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ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

Report on

WASTE SOURCE INVESTIGATIONS
HOLSTON ARMY AMMUNITION PLANT
KINGSPORT, TENNESSEE

National Field Investigation Centers-Denver and Cincinnati
and
Region IV, Atlanta, Georgia

March 1973

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GLOSSARY OF TERMS

BOD	- Biochemical Oxygen Demand, 5-day
COD	- Chemical Oxygen Demand
TOC	- Total Organic Carbon
SS	- Suspended Solids
TKN	- Total Kjeldahl Nitrogen
NH_3-N	- Ammonia as Nitrogen
$NO_3 + NO_2$-N	- Nitrate + Nitrite as Nitrogen
Total-P	- Total Phosphorus
Cr	- Chromium
Mn	- Manganese
Fe	- Iron
Cu	- Copper
Zn	- Zinc
Sn	- Tin
Hg	- Mercury
Pb	- Lead
RM	- River Mileage (e.g., 142.15/4.04) with first number denoting distance from the mouth of the Holston River to the confluence with a tributary upstream, and second value indicating distance upstream of the mouth of the tributary stream.
TL_m	- Median Tolerance Limit, the concentration of toxicant in water that causes a 50 percent mortality of the test fish over a specified time period.
WWTP	- Wastewater Treatment Plant

cfm	- Flow rate given in cubic feet per minute
cfs	- " " " " " " " second
gpm	- " " " " gallons per minute
gpd	- " " " " " " day
gpw	- " " " " " " week
mgd	- " " " " million gallons per day
mg/l	- Concentration given in milligrams per liter
mg/kg	- " " " " " kilograms
µg/l	- " " " micrograms per liter
µmhos/cm	- Unit of specific conductance (mho--the inverse of the standard unit of electrical resistance, the ohm) measured over a 1-centimeter distance, conventionally at 25°C.
ppm	- Concentration given in parts per million

I. INTRODUCTION

A. BACKGROUND

The South Fork of the Holston River as it flows through the City of Kingsport, Tennessee and the Holston River* downstream from Kingsport are polluted from discharges of inadequately treated and/or untreated industrial and municipal wastes. A study conducted by the Federal Water Quality Administration, Department of the Interior, Region IV, during June-July, 1969, reported that:

1. Wastewater discharges from the Tennessee Eastman Company (TEC); Holston Army Ammunition Plant Areas A and B (HAAP-A&B); Mead Papers a division of Mead Corporation; Kingsport Wastewater Treatment Plant; and Holliston Mills contributed approximately 137,500 lb/day of BOD and 22,000 lb/day of total nitrogen to the Holston River system.
2. Cooling-water discharges from TEC and HAAP-A raised the ambient water temperature of the South Fork of the Holston River by about 12°C.
3. Attached aquatic weeds (primarily *Potamogeton pectinatus*) covered the bottom of the Holston River throughout the reach of the 23 river miles studied. This resulted in a cyclical variation of oxygen levels and caused violations of the Tennessee Stream Standards for dissolved oxygen.

The Tennessee Water Quality Control Board subsequently established

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* The Holston River and the South and North Forks of the Holston River are interstate streams.

effluent requirements which specified that those industries discharging to the Holston River and its tributaries provide a minimum BOD removal of 85 percent by April 1972. The 1969 survey concluded that the BOD load discharged in the study reach must be reduced by 92 percent if water quality conditions were to improve. The study further concluded that the two largest dischargers, TEC and HAAP-B, must reduce the total Kjeldahl nitrogen in the effluents by 92 percent.

To date, the 85-percent BOD-removal goal has not been met. However, with the passage of the Federal Water Pollution Control Act Ammendments of 1972, previous State goals and implementation plans have been revised to maintain a minimum dissolved oxygen of 5 ppm in the River. The State of Tennessee is planning to hold a public hearing regarding the water pollution problems in the Kingsport area, but no date has been set. Additionally, the State has not requested interim authority from EPA to issue permits under the 1972 Amendments.

B. 1972 WATER-QUALITY INVESTIGATIONS

The National Field Investigations Center-Denver (NFIC-D) was requested by EPA Region IV, Atlanta, Georgia, to conduct waste-source evaluations and a stream survey in the Kingsport, Tennessee, area-Holston River Basin with the following objectives:

1. Determine the quality and quantity of waste pollutants discharged to the Holston River and its tributaries so that effluent limitations can be established pursuant to the Federal Water Pollution Control Act Amendments of 1972.

2. Ascertain the changes in water quality of the Holston River and its tributaries due to waste discharges.
3. Evaluate present pollution control measures and determine what additional abatement measures are necessary for the protection and enhancement of receiving water quality.

The study was conducted by the National Field Investigation Center-Denver and Cincinnati during the period 27 November through 15 December 1972. This report summarizes the results of the NFIC investigations of the Holston Army Ammunition Plant-Areas A and B. Sources of pollution and the resulting effects of wastewater discharges on the water quality of the Holston River and its tributaries are discussed. Results of the NFIC investigations of other waste sources in the Kingsport, Tennessee area are discussed in the report entitled, *Waste Source Investigations-Kingsport, Tennessee.*

The cooperation extended by Holston Army Ammunition Plant personnel and State and Federal agencies is gratefully acknowledged.

II. CONCLUSIONS

A. HOLSTON ARMY AMMUNITION PLANT-AREA A

1. The HAAP installation had virtually no treatment of industrial process wastes and contaminated cooling waters. The total wastewaters, including spent cooling waters, being discharged from the Holston Army Ammunition Plant, Area A, into the South Fork of the Holston River was 43.3 mgd. These wastewaters had average measured amounts of 20,300 lb/day BOD; 19,100 lb/day COD; and 4,060 lb/day suspended solids. Due to the complex nature of HAAP wastes and their potential effect upon analytical tests, these results most likely represent minimum values.

2. The Main Outfall discharge (Station 2) was found to contain more than 90 percent of the total BOD and COD loads being discharged from the overall HAAP A complex. This discharge also represented about 75 percent of the total facilities wastewater flow. Effluents from the ASG Industries were discharged into the upper section of the HAAP Main Outfall, amounting to approximately 3,600 lb/day of suspended solids in a waste flow of 0.52 mgd. Many of these solids settled out in the open ditch either before reaching or within the Main Outfall.

3. Bioassay studies conducted at HAAP, Area A, disclosed that wastewater discharges at Stations 2 and 8 were highly toxic to aquatic life. The coal-tar drainage (0.007 mgd) at Station 8 killed 50 percent of the fathead minnow test species after 96 hr with a waste concentration of only 0.17 percent. The Main Outfall (33.6 mgd) at Station 2 showed a 50 percent kill of test fish after 96 hr with a waste concentration of 56.0 percent. These two waste discharges alone would require that

about 2,000 cfs be maintained in the South Fork and Holston Rivers to ensure no long-term impact on aquatic life because of toxicity (based upon 1/20 of the 96-hr TL_m). This calculated dilution flow does not include additional allowance for the many other potentially toxic waste streams presently entering the Holston River, not only from the remaining parts of HAAP A, but also HAAP B, Tennessee Eastman, and miscellaneous sources. The concentrations of toxic materials in the Holston River downstream from Kingsport, Tennessee, are approaching the levels that are toxic to fish. These toxic discharges are in violation of the General Water Quality Criteria for the Definition and Control of Pollution In the Waters of Tennessee for Fish and Aquatic Life-subsection 3(g). If included in the process waste stream for waste treatment purposes these two waste streams may seriously interfere with the efficacy of the proposed biological treatment.

4. The Area A wastewater-treatment program relies exclusively upon completion and adequate performance of the aerated lagoon (i.e., Phase II). The full-scale lagoon is scheduled for operation by February 1976. In the interim, process wastes will be discharged without treatment to the South Fork of the Holston River, and projects completed prior to this data (e.g., the tank-farm dike project and collection of boiler blowdown and steam-plant wastes for treatment) will not be functional as all the wastes are designed to ultimately flow to the lagoon.

5. Treatment performance criteria used for the design of the aerated lagoon system are not expected to meet APSA Guidelines or Water Quality Standards Requirements. The system, as described, is incompatible with

best practicable control technology. Design criteria were based upon USAEHA derived waste loads which were found considerably lower than the EPA 1972 survey loads. Consequently, expected treatment performance may be greatly altered. Questions are also raised on the applicability of biological treatment to the HAAP wastes. Modification of the criteria, or even the concept itself, could be necessary.

6. A significant air pollution problem exists in Area A. Measures are presently underway to alleviate some of these air pollution emissions.

B. HOLSTON ARMY AMMUNITION PLANT-AREA B

1. At Area B, the total discharge to the River was 84.4 mgd, containing a net BOD of about 10,000 lb/day. The applicability of the BOD test to some of these waste streams, which may contain nondegradable or even toxic materials, is questionable.

2. In the EPA survey, only about 100 lb of ammonia/day are discharged in the wastewater effluent. Other surveys showed up to almost 2,500 lb/day in the effluent streams. Almost 2,500 lb of the nitrate and nitrite ion/day are discharged into the Holston River.

3. Waste treatment facilities designed by CERL and based on standards of the State of Tennessee were not designed in accordance with the best practicable control technology currently available.

4. All solids removed in the water treatment facility and from steam production are sent untreated to the river.

5. A significant air pollution problem exists in Area B. Measures are presently underway to alleviate some of these air pollution emissions.

6. Static bioassay studies on Streams 29 and 30 after mixing but before entering the river has a 96 hr TL_m value of 23 percent. The combined flow was 16.72 mgd. A factor of 1/20 was used to obtain a river flow that would dilute this so that there would be no long-term impact on aquatic life. A bioassay on stream 31 (at 2.3 mgd) showed a 96 hr TL_m of 23 percent. Similar calculations were performed on this flow. The summation of the two bioassay calculations indicated that a minimum flow of 2,600 cfs would have to be maintained in the river. This figure does not include dilution water that would be necessary to protect the aquatic life from discharges at Area A, Tennessee Eastman Company, or other sources in the area.

III. RECOMMENDATIONS

1. To meet water-quality standards in the Holston River and the requirements of the National Pollution Discharge Elimination System the following effluent limitations are recommended for the Holston Army Ammunition Plant (Areas A & B) located in the vicinity of Kingsport, Tennessee:

A. BOD not to exceed 2,400 lb/day
   Area A-1,000 lb/day
   Area B-1,400 lb/day

B. TKN not to exceed 100 lb/day
   Area A-10 lb/day
   Area B-90 lb/day

C. Heavy metals not to exceed 150 lb/day
   Area A-30 lb/day
   Area B-120 lb/day

D. Phenolics not to exceed 5 lb/day
   Area A-1 lb/day
   Area B-4 lb/day

E. No detectable discharge made of potentially toxic organic wastes

F. SS shall not exceed 30 mg/l in process wastes and background in cooling water. In the process waste, the SS limit shall be 4,600 lb/day.
   Area A-1,000 lb/day
   Area B-3,600 lb/day

G. Nitrate and nitrite nitrogen shall not exceed 1 mg/l in process wastes and background in cooling water. In the process wastes the nitrate-nitrite shall be limited to 150 lb/day.
   Area A-30 lb/day
   Area B-120 lb/day

2. The Army Munitions Command shall provide to the Environmental Protection Agency, Region IV, by not later than 15 July 1973, a treatment

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NOTE: Effluent limitations A through D refer to net additions to raw intake water.

system and schedule of abatement necessary to meet the effluent limitations established in recommendation number one by 1 July 1977. A suggested treatment system which could meet these limitations is:

A. Separation of process wastes and major uncontaminated cooling water streams to the maximum extent feasible

B. Pretreatment measures to protect the biological treatment process

C. Activated sludge

D. Deep-bed filtration

E. Carbon adsorption

F. Denitrification

3. Sludges, solids, and debris resulting from water treatment process at both Areas A and B shall be dewatered and removed to approved landfill with no discharge to receiving waters.

4. Wastes resulting from discharges in the tar-tank storage area shall be completely contained and not discharged to receiving waters nor included in any process-waste streams that discharge to the waste treatment system. There shall be no discharge of this coal tar waste to receiving waters.

5. For the tank-farm- and chemical-storage areas HAAP shall develop a strong spill prevention, containment, and countermeasure program as soon as possible. Such a program and associated plan of action shall, as a bare minimum, incorporate preventive maintenance and inspection; adequate capacity diking or curbs shall be constructed around all tanks or groups of tanks so as to prevent a) chemicals leaking or spilling from the tanks and b) any storm water contaminated with chemicals from entering

a receiving watercourse. In no event shall spills, be allowed to enter sanitary, process, or cooling-water sewers. Complete containment and separate recovery or treatment of spills, leaks, and associated drainage are recommended.

6. All additional effluent requirements established by the State of Tennessee shall be met.

IV. STUDY AREA

A. GENERAL DESCRIPTION

The study area [Figure 1, inside back cover] lies within the Holston River Basin in the rugged hill country of Northeastern Tennessee and includes portions of Sullivan and Washington Counties. The Holston River is formed by the confluence of the South and North Forks of the Holston River, at Kingsport.

Kingsport and Johnson City, Tennessee, and Bristol, Virginia, form the "Tri-Cities" metropolitan area. Kingsport (population, 30,800), located in Sullivan County, is the only city located within the study area. It is the most industrialized of the three cities and provides jobs for more than 34,000 people. Since 1960, the city has grown at an annual rate that exceeds 17 percent. The majority of the development has been along the South Fork of the Holston River.

B. ECONOMICS

A detailed study of the economic growth in eastern Tennessee and western Virginia reported that manufacturing is the major industry, employing 73,200 persons. Chemicals and allied products, apparel, and textile products are the leading industries. The pulp and paper industry is projected as having the major growth potential. Employment in the region is anticipated to increase from its present rate of 31 per 100 population to 36 per 100 population by the year 2020.

C. HYDROLOGY

The Tennessee Valley Authority (TVA) has constructed a series of

impoundments upstream of Kingsport on the South Fork of the Holston River and its tributaries to control flooding and generate hydroelectric power. The flow in the North Fork is unregulated. The 20 year* three-day low flow in the North Fork, recorded at Gate City, Virginia, is 46 cfs, and the mean daily discharge is 851 cfs. The TVA is required to release water from Fort Patrick Henry Dam to maintain a minimum daily flow of 450 cfs in the South Fork of the Holston River. However, the Tennessee Eastman Company requires a minimum daily stream flow of 750 cfs for process and cooling water. The company purchases the additional water from the TVA.

* The Tennessee Water Quality Criteria are applied on the basis of two definitions of minimum flow: (1) unregulated streams--3-day minimum, 20-year recurrence interval, and (2) regulated streams--instantaneous minimum.

V. APPLICABLE WATER QUALITY STANDARDS AND REGULATIONS

A. WATER QUALITY STANDARDS

The Holston River, an interstate stream, and the South Fork of the Holston River are used for public water supply, industrial water supply, recreation, hydroelectric power, agricultural purposes, and receipt of treated wastes. Within the study area, all the rivers and streams investigated, with the exception of Hales Branch (not classified) and North Fork are classified as suitable for "Fish and Aquatic Life." In addition, the Holston River downstream (RM 131.5) from Kingsport is classified as "Domestic Raw Water Supply." [The Tennessee Water Quality Criteria are contained in Appendix A.]

The criteria and standards require that all wastes will receive the best practicable treatment (secondary or equivalent) or control according to the policy and procedure of the Tennessee Water Quality Control Board. A degree of treatment greater than secondary, when necessary to protect the water uses, will be required for selected sewage and waste discharges.

Specific standards applicable to this survey include:

1. Dissolved Oxygen--The dissolved oxygen shall be maintained at 5.0 mg/l except in limited sections of the stream receiving treated effluent. In these limited sections,* a minimum of 3.0 mg/l dissolved oxygen shall be allowed. [These limited sections are mixing zones which refer to that section of the

* The EPA has requested that Tennessee upgrade Water Quality Criteria for these sections to 5.0 mg/l DO and to establish a fecal coliform criteria of 2,000/100 ml for water classified for fish and aquatic life.

flowing stream or impounded waters necessary for effluents to become dispersed. The mixing zone necessary in each particular case shall be defined by the Tennessee Water Quality Control Board.] The dissolved oxygen content shall be measured at mid-depth in waters having a total depth of ten (10) feet or less and at a depth of five (5) feet in waters having a total depth of greater than ten (10) feet. Minimum dissolved oxygen content of 6.0 mg/l shall be maintained in recognized trout streams.

2. pH--The pH value shall lie within the range of 6.5 to 8.5 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.
3. Solids, Floating Materials and Deposits--There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life.
4. Turbidity or Color--There shall be no turbidity or color added ir such amounts or of such character that will materially affect fish and aquatic life.
5. Temperature--The maximum water temperature change shall not exceed 3°C relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2°C per hour. The temperature of recognized trout waters shall not exceed 20°C. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. The temperature

of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

6. Taste or Odor--There shall be no substances added that will impart unpalatable flavor to fish or result in noticeable offensive odors in the vicinity of the water or otherwise interfere with fish or aquatic life.
7. Toxic Substances--There shall be no substances added to the waters that will produce toxic conditions that affect fish or aquatic life.
8. Other Pollutants--Other pollutants shall not be added to the waters that will be detrimental to fish or aquatic life.

B. FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972

Under the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA), existing water quality standards for interstate waters are preserved. In addition, the Act requires the preparation of water quality standards applicable to intrastate waters. The existing mechanism for State establishment, Federal review and promulgation and review of water quality standards is continued.

Hales Branch, a tributary to the South Fork of the Holston River, falls within this intrastate category; water quality standards must therefore be established.

The Act also provides that all point sources of pollution other than publicly owned treatment works, which discharge directly into the

Nation's waters are required to achieve, not later than July 1, 1977, effluent limitations which shall require the application of the "best practicable control technology currently available." The same point sources must achieve effluent limitations which shall require the application of the "best available technology economically achievable" by July 1983. Point sources discharging into publicly owned treatment works must comply with pretreatment standards as prescribed by the EPA. EPA will also limit the discharge of pollutants determined to be toxic and where appropriate may require an absolute prohibition of the discharge of such toxic pollutants.

Publicly owned treatment works must meet effluent limitations by July 1, 1977 which are based on "secondary treatment" as defined by EPA. By July 1, 1983, public plants must meet "best practicable waste treatment technology."

The established effluent limitations for each individual point source will be applied as conditions of permits to be issued under the National Pollutant Discharge Elimination System as established by the Act.

In cases where the prescribed effluent limitations will not achieve a level of water quality consistent with water quality standards and suitable for swimming and sustaining a balanced population of fish, shellfish and wildlife, EPA may impose more stringent effluent limitations as may be necessary to achieve that goal.

VI. HOLSTON ARMY AMMUNITION PLANT-AREA A

A. GENERAL

The Holston Army Ammunition Plant (HAAP) is located on two separate sites (Area A and Area B) in the vicinity of Kingsport, Tennessee. Area A, within the corporate boundaries of Kingsport, occupies about 134 acres and borders on the South Fork of the Holston River [Figure 1]. Area A abuts industrial properties of the Tennessee Eastman Company (TEC) and the ASG Industries.

Area A is the organic acid manufacturing facility of HAAP, whereas Area B is the nitric acid and explosives manufacturing facility. Major processes at HAAP, Area A, include the manufacture and refining of acetic anhydride and the concentrating and refining of acetic acid, principally recovered from HAAP, Area B.

HAAP is the only munitions plant under the auspices of the Army Procurement and Supply Agency (APSA) that is devoted to the manufacture of RDX-HMX explosives. RDX and HMX are admixed with TNT (TNT being received from the outside) and various chemicals, densensitizing agents, fillers, etc., for primary use in manufacturing military explosives. Additionally, explosives are prepared for the National Aeronautics and Space Administration. HAAP reports the manufacture of about 50 RDX-HMX product variations of which Composition B is the most prominent: it is an extremely powerful explosive made up of RDX, TNT, and wax.

At Area A, waste acetic acid from Area B is concentrated, refined and re-used in process operations. Areas A and B, are interconnected by a railroad spur that is part of the Clinchfield Railroad System and

by a series of stainless steel pipelines laid along the railroad tracks which convey raw materials and intermediate products between the two manufacturing facilities.

The Holston Army Ammunition Plant, owned by the Department of the Army, is operated and managed by the Holston Defense Corporation (HDC - a subsidiary of the Tennessee Eastman Company) on a contractual agreement with the Department of the Army. Line command proceeds downward from the Department of the Army through Army Materials Command (AMC) to the Army Ammunition Procurement and Supply Agency (APSA), then Munitions Command (MUCOM), and then to HAAP.

The Department of the Army has undertaken a long-term program for modernizing its munitions and loading facilities. This modernization program, under APSA, spans from 1969-1980 at a projected cost of $2.5 billion. The largest aspects of the program are mechanization, replacement, new construction, and pollution abatement. Modernization program funding is controlled by Congressional appropriation to the U. S. Army Corps of Engineers for military construction, i.e., MCA. The Army is responsible for funding pollution abatement measures necessary to conform to State standards and criteria; the requirements under Federal legislation and Executive Order 11507; and most recently, the best practicable control technology currently available and best available treatment measures as described in the Federal Water Pollution Control Act Amendments of 1972.

HAAP Areas A and B are operated continuously and are staffed by two Army officers, 40 Civil Service personnel, and approximately 1,950 employees

of the Holston Defense Corporation. During late 1972, the HAAP manufacturing facilities were being operated at around 43 percent of full capacity.

Permit applications under the 1899 Refuse Act have previously been filed with the U. S. Corps of Engineers for all waste discharges from HAAP, Areas A and B. There are 13 waste outfalls from Area A and 8 outfalls from Area B.

EPA personnel from NFIC-Denver and Cincinnati, and Region IV, Atlanta, Georgia together with Tennessee State Health Department representatives met with HAAP personnel at Kingsport, Tennessee, on 16 October 1972. They discussed process operations and the pollution potential of existing wastewater streams. Considerable information was obtained but Federal and State representatives did not view the process or wastewater operations. Subsequently, the EPA personnel conducted industrial site and river water pollution surveys. Area A, was studied from 30 November to 3 December 1972. Mr. Robert Banner, Jr., Chemical Engineer at HDC; provided information and assistance during the industrial surveys.

B. UTILITIES AND WATER SUPPLY

HAAP, Area A, purchases electricity, potable water (approximately 200,000 gal./day), and domestic sewer services from the City of Kingsport. Area A has a central steam generating plant consisting of seven boilers fired by "non" low sulfur content coal. Furnace fly ash is slurried into a 4 ft by 4 ft settling compartment followed by a 10 ft by 20 ft pit having continuous overflow. Coal is also utilized in the manufacture of producer gas at HAAP A. The producer gas is added to the

cracking furnaces in forming the acetic anhydride. Producer gas is basically a gaseous fuel formed from the incomplete combustion of coal or coke, and consisting mostly of nitrogen, carbon monoxide, hydrogen and carbon dioxide. It is also a viable source of phenolics in resulting wastewaters.

Various amounts of water for cooling and process needs are withdrawn from the South Fork of the Holston River; previously reported figures on total withdrawals vary considerably. River water is diverted into a canal located on the south bank of the South Fork and originating a short distance upstream of the Tennessee Eastman Company waste outfalls. River water enters Area A via a pump station with attendant trash racks. A portion of this flow is treated on-site. Average river water intake varies from about 45 to 65 mgd. The cooling water (once-through) flows for the total facility range from 42 to 60 mgd; process water flows range from 0.8 to 4.4 mgd. The wide range in water use figures reportedly is due to the lack of precise measurement of incoming water flows.

This study assumes that approximately 42 mgd is employed for once-through cooling and 0.8-0.9 mgd for processing at Area A. Furthermore, recent data from HAAP indicate that about 1.5 mgd of intake water is treated (softened and filtered) of which about 0.8 mgd is used for boiler feed and 0.7 mgd for process waters. Spent cooling waters, water-works filter sludges, and industrial process wastewaters from Area A are discharged without treatment to the South Fork of the Holston River.

C. PROCESS OPERATIONS AND WASTE SOURCES

The general layout of manufacturing buildings at Area A is shown

in Figure 2. A simplified flow sheet of Area A is presented in Figure 3. The major processes conducted at Area A are as follows:

1. Concentration and refining of waste acetic acid (received from HAAP B) by means of azeotropic distillation units in Building 2 yields an acetic acid whose concentration is increased from 60 percent to approximately 99 percent pure (glacial acetic acid). About one-third of the glacial acetic acid is returned to Area B for explosives manufacturing; two-thirds are employed in the manufacture (within Area A) of 98 percent acetic anhydride. Interim storage of the refined acid (99 percent pure) is provided for in the tank farm areas.
2. Acetic anhydride manufacturing is carried out (in Buildings 7 and 20) by first catalytically cracking glacial acetic acid in special cracking furnaces (fueled by producer gas) and secondly absorbing the cracking products in glacial acetic acid to yield the crude anhydride, which is then refined (Building 6).
3. Generation of producer gas (Building 10) is carried out upon demand by the cracking furnaces in the acetic anhydride manufacturing processes.
4. Refining of the crude anhydride by distillation (Building 6) produces a high purity acetic anhydride, required for the various explosives manufacturing operations in HAAP, Area B. It should be noted that Building 6 has two distinct functions: a) acetic anhydride refining and b) azeotropic distillation to purify and concentrate acetic acid.

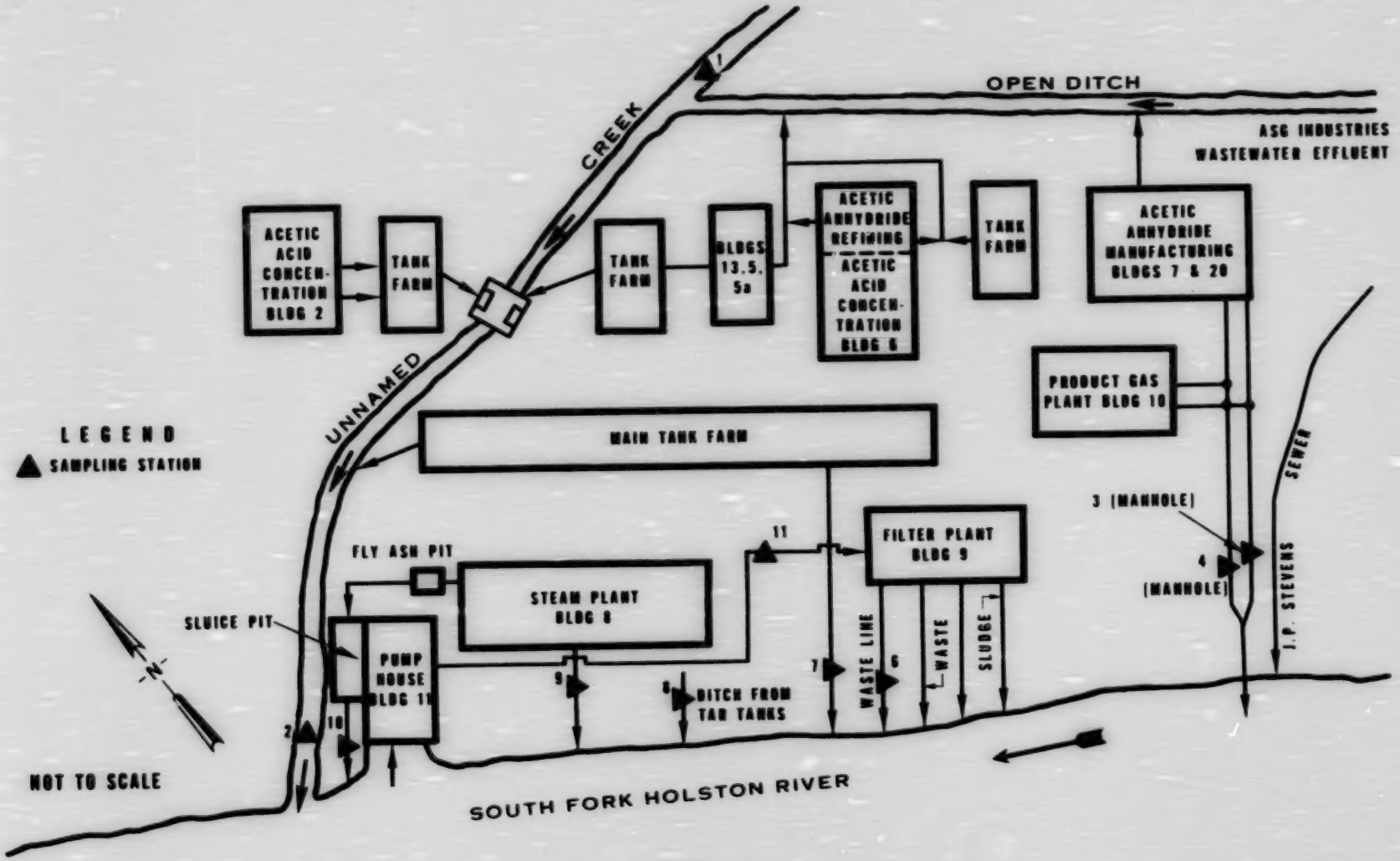

Figure 2. Plant Layout-Holston Army Ammunition Plant-Area A
Kingsport, Tennessee

2/a

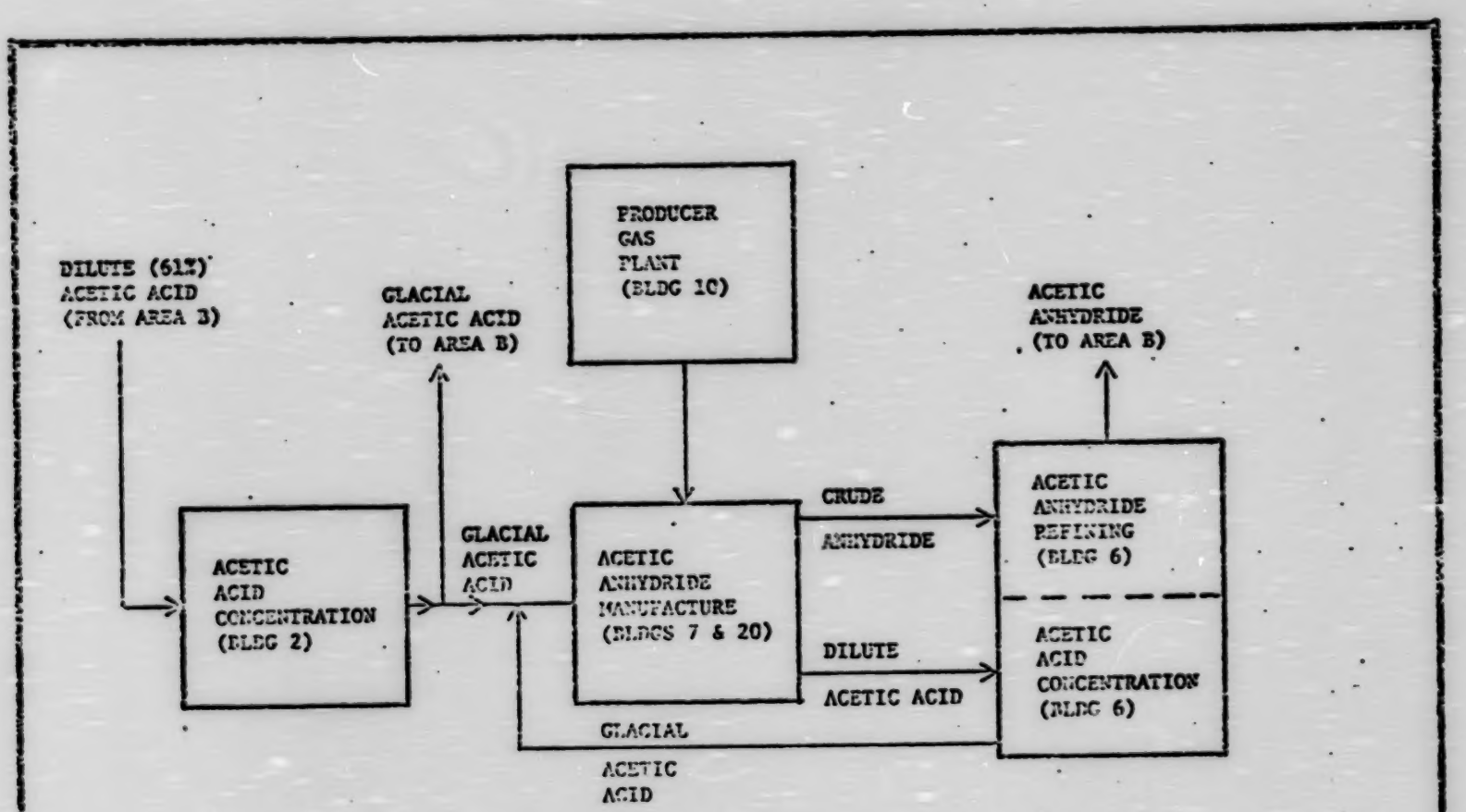

Figure 3. SIMPLIFIED FLOWSHEET-AREA A, HOLSTON ARMY AMMUNITION PLANT

Courtesy of USAEHA, Edgewood Arsenal,
Aberdeen Proving Ground, Maryland
Taken from USAEHA Study No. 24-021-71/72

5. Mechanical refrigeration services (Building 5)
6. Generation of steam with coal fired boilers (Building 8) provides for the needs of the entire HAAP, Area A complex.

Acetic Acid Concentration and Refining--Building 2

In azeotropic distillation, the nearly pure acetic acid is withdrawn from the bottom of the column, and the *n*-propylacetate-and-water mixture is removed from the top of the column and condensed. Separation of water from the acetate is accomplished by decantation. The propyl acetate is then returned to the azeotropic distillation column. The decanted waters are passed through a flash column for further solvent recovery before they are discharged to the sewer.

During distillation there is a undesirable buildup of solids in the distillation column. Sludge bleedoff is necessary, with this material being sent to a sludge-heating operation. Under elevated temperature and vacuum, additional acetic acid is distilled and recovered via the overhead streams until the acid concentration falls below the level deemed economically recoverable. At this point the sludges are dumped into the sewer. Sludge heating is a batch operation. Exhausted sludges are dumped sporadically, between two to four times each week. Occassionally spent sludges contain heavy metals (including Cr, Cu, Fe, and Mn) from the corrosive destruction of materials which form the distillation columns.

Flash column effluent waters and sludge heater wastes are cited in the 1971 Army Environmental Hygiene Agency (AEHA) Report as totaling 24,000 gpd and 16,000 gpw, respectively. However, the 1971 MUCOM

report for HAAP reports a process wastewater flow of 312,000 gpd from Building 2 (also, presumably for the decant waters). These process effluents range in pH from 2.8 to 3.8 and contain nitromethane, methyl nitrate, acetic acid, *n*-propyl acetate, nitric acid and trace amounts of explosives.

Cooling and condensing water usage (in Building 2) for the distillation units and peripheral operations are estimated as 24.0 mgd. Acetic acid (99 percent) production is about 1.3 to 1.6 million lb/day. Cooling waters, process waters and sludges are mixed in the Building 2 industrial sewer and discharged into the "Main Outfall Ditch" adjacent to Building 2. This ditch was sampled at Station 2 during the NFIC-D, 1972 survey, immediately before its entry into the South Fork of the Holston River [Figure 2].

Another pollution source from the acetic acid operations (Building 6), is vent gas from the azeotropic distillation columns. Under current production rates, these vent gases contain about 530 lb/day of methyl nitrate liberated in a total, untreated mixture of nitromethane, methyl acetate, propyl formate, propyl acetate and methyl nitrate. The weight of solvent vapors vented to the atmosphere approaches some 1,070 lb/day. Methyl nitrate is toxic and highly explosive.

Acetic Anhydride Manufacturing--Buildings 7 and 20

Glacial acetic acid (from Building 2) is vaporized and fed to the cracking furnace (in Buildings 7 and 20) together with triethyl phosphate, a reaction catalyst. Furnace vapors are passed through a condenser which separates the process stream into a) uncondensed vapors and

b) unreacted acetic acid obtained from the bottom of the condenser. The unreacted acid is sent to Building 6 for re-concentration.

Uncondensed vapors are directed through a series of five scrubbing units; the primary, secondary, anhydride, weak acid and water scrubbers. The scrubbers employ recycling of feed, bottoms, and intermediate product streams. The vapor stream is scrubbed with glacial acetic acid, and ketene originating from catalytic cracking is absorbed to form the anhydride. Crude anhydride is taken off the bottom of the secondary scrubber and subsequently sent to the distillation unit (Building 6) for refining. Wastewaters from acetic anhydride production (Buildings 7 and 20) are principally generated at the fifth (i.e. the water) scrubbing unit. Vapors entering the fifth unit are scrubbed with water; after a single pass they enter a drain sump and the plant sewer. Non-condensables off the top of the fifth unit are captured in a barometric condenser that likewise discharges to the drain sump. Both the barometric system and drain sump are vented to rid the production area of noxious fumes. It is likely that drips, leaks, spills, etc., in the production area are also directed to the drain sump.

Spent gases from the cracking furnaces are sent to a waste heat boiler that receives deionized water for low pressure steam generation. Flue gas from the boiler, in addition to any unburned producer gas, is directly vented to the atmosphere.

The flow of the process wastewater streams that include the water scrubber discharges and barometric condensates previously mentioned ranges from 500,000 to 550,000 gpd. These wastewater streams are

reported to contain acetic anhydride, acetic acid, acetaldehyde, acetonitrile, methyl acetate, methyl nitrate, ethanol, methanol, ethyl acetate, propanol, propyl acetate, etc. A previous Army report equates the water scrubber discharge to 3,100 lb BOD/day.

The volume of the cooling waters for anhydride manufacturing amount to 2.0 to 2.3 mgd which are mixed with process wastewaters in the building sewer for discharge to the South Fork of the Holston River. These discharges were collectively measured and analyzed at the Process Waste Outfall (Station 3) during the EPA survey, 30 November-3 December 1972. The conditions just expressed are representative of acetic anhydride production rates in the range of about 510,000 to 640,000 lb/day.

Pollutants similar to those found in the wastewater streams can be expected in the various off-stream gases vented to the atmosphere (from Buildings 7 and 20). Of the contaminants resulting from anhydride manufacturing some 16,500 lb/day of air pollutants are estimated to be currently discharged (from Buildings 7 and 20); this total is comprised of 5,440 lb/day of hydrocarbons, 6,360 lb/day of carbon monoxide and 4,700 lb/day of carbon dioxide mixed with hydrogen.

Producer Gas Plant--Building 10

Producer gas manufacturing facilities (Building 10) are rated at a capacity of about 2.0 million cubic feet of gas per day. A heated, saturated steam-air mixture is added to coal, burning in the gas producer furnaces, where combustion is maintained around 1,100°F. Ashes are withdrawn from the bottom of the furnaces and disposed of by removal to a landfill.

The products of this combustion pass through water sprays, a tar trap, and then into two large water scrubbing units in series. Scrubbing removes dust, tars, phenolics, etc. from the gases but these pollutants then find their way into the wastewater flows. Spent water from the header sprays and the scrubbing units is decanted for removal of tars which are sent to the steam plant as fuel. Decanter effluents flow through a cascade cooler prior to being recycled to the sprays and scrubbers or are discharged to the plant sewer. Total water usage and ensuing wastewater discharges associated with the manufacture of producer gas heavily depend upon the degree of recycling of decanter effluents back into the system. The Army reports that flows of "excess" cooling and condenser water from the producer gas building amount to from 170,000-180,000 gpd. Flow measurements made at Station 4 during the 1972 EPA survey (November-December) 1972 indicate the wastewater contribution from Building 10 was many times higher than that reported by the Army. However, wastewater loads from this plant, as measured at both Stations 3 and 4 (EPA survey stations), were reflected, within the results obtained.

Other pollution sources within the producer gas area include sludges from an on-site evaporator and cleanout of the tar traps. These materials are disposed of at a sanitary landfill. Air contaminants from the producer gas furnace vent gases include particulate matter, and sulfur and nitrogen oxides.

General operations data indicate that approximately 56 cu ft of producer gas are obtained for each pound of coal burned and that about

14.3 cubic feet of producer gas are consumed per pound of crude acetic anhydride formed.

Acetic Anhydride Refining--Building 6

Building 6 actually houses two different process operations: acetic anhydride refining, accomplished by distillation, and acetic acid concentration accomplished by azeotropic distillation. Anhydride refining constitutes the major operation. Crude anhydride is received from the dehydration process (Buildings 7 and 20) or from storage tanks, whereas the low-grade acetic acid is obtained as a by-product of the anhydride refining columns.

Crude anhydride, acetic acid and impurities are received into two-stage refining columns heated in the lower stage. Refined anhydride is withdrawn from the lower stage, sent to a second (small) column for removal of color bodies, and is then ready for storage or pipeline transport to HAAP, Area B. The vapors from the top of the two-stage anhydride column contain acetic acid, 15 percent anhydride plus some impurities. This vapor is condensed, part being returned to the refining column and the majority sent to a stripping column. In stripping, separation is made into a) acetic acid and anhydride (off the bottom of the stripper) which are returned to the refining column, and b) 90-percent acetic acid vapors off the top of the stripper. These vapors serve as the feed for the azeotropic stills (located in Building 6).

Azeotropic distillation of acetic acid for purification and concentration is similar to that performed in Building 2 (production of 99 percent pure acid). In Building 6 the acetic acid feed to the stills contains

low-boiling compounds that must be removed before azeotropic distillation. Prior to distillation, the feed is passed through a stripping column, to reduce the low boilers and release these compounds to the atmosphere. Vented streams contain acetonitrile, methyl acetate, acetaldehyde, methanol, ethanol, methyl nitrate, ethyl acetate, propanol and propyl acetate, all of which then become air pollutants. Other sources of air pollution exist in Building 6. The major source is the azeotropic stills, for which there is no waste load information presently available.

Sludge bottoms from the various stills in Building 6 are recovered. Sludges from the refining columns are sent to a ball mill, then heated under vacuum to distill off additional acetic anhydride. When the anhydride falls below an economically recoverable level, the sludges are dumped to the sewer, a daily occurrence. Sludges from the azeotropic stills, because of their anhydride origin, receive preparatory treatment by sulfuric acid to break down the acetamide in the sludges. The sludges are then sent to sludge heaters and handled in a similar fashion to those in the acetic acid purification process (Building 2). In like manner exhausted azeotropic still sludges are eventually discharged into the plant sewer.

Process wastewater sources from anhydride refining (Building 6) include a) 70,000 gpd ball mill sludges containing carbon polymers, acetic anhydride, etc.; b) 8,100 gpd of sludge heater sludges that are dumped four times per week -- containing carbon, ammonium phosphate, acetamide, and various polymers; and c) flash column effluent, in the acetic acid concentration area, having unknown volume but found to

contain acetone, ethyl acetate, acetonitrile, and methyl cyanide.

Total spent cooling and condensing waters from anhydride refining (Building 6) are estimated by the Army as around 9.5 mgd. All spent flows leaving Building 6 are untreated and mixed together in the industrial plant sewer. These streams were collectively analyzed with other wastewaters passing Station 2 during the EPA 1972 survey. Conditions described are representative of acetic anhydride production in the range of 600,000 to 700,000 lb/day and acetic acid production of 120,000 to 150,000 lb/day.

Mechanical Refrigeration--Building 5

The anhydride scrubber medium (in Buildings 7 and 20) is cooled by an ethylene glycol solution. The glycol, after use, is cooled by mechanical refrigeration equipment (located in Building 5) and, in a closed loop system, is returned to the anhydride units. Spent cooling waters from the refrigeration operation (Building 5) have been estimated to range from 0.164 to 2.3 mgd. These waters are expected to contain substantial amounts of heat.

Steam Generation at Steam Plant--Building 8

Except for a single boiler that employs pulverized coal, steam-producing boilers (Building 8) are stoker fired. Tar sludges received from the producer gas builing are also put into the boilers. Boiler feed consists of a mixture of deionized water and return steam condensates. In order to minimize corrosion in the boilers, sodium sulfite is added to the feed waters. Sodium phosphate is added directly to the

boiler drums to reduce corrosion and scale formation on the boiler tubes. The boilers are blown down more or less continuously so as to prevent too high a solids concentration in the boiler system. Both high and low-pressure steam are produced for needs throughout Area A. Compressed air requirements for Area A are met by equipment within Building 8.

Spent ashes from the bottom of the boilers are slurried into an ash pit followed by a sluice pit. The overflow from the sluice pit is estimated from 100,000 to 140,000 gpd; the flow was sampled at EPA survey Station 10. The Army describes this water as strong in phosphates and sulfites. Pump gland drainage from the water pumping house adjacent to the steam plant also contributed a considerable amount of flow passing EPA Station 10.

Boiler blowdown is released into the drainway, monitored by Station 9 during the EPA survey. This discharge reportedly has a high temperature and contains significant quantities of phosphates, sulfates and sulfites. The Army has provided a flow figure for boiler blowdown (from Building 8) of approximately 30,000 gpd although survey results for Station 9 indicated some 690,000 gpd; this reflects additive wastes such as general washdown and cleanup waters, spills, leaks, or unknown water uses.

Coal tars recovered from the producer-gas building are conveyed to storage tanks directly adjacent to the steam plant. Tar deposits on the grounds around the storage tanks are slowly leached into the drainway on the southeast side of the steam plant and eventually discharged to the South Fork of the Holston River. This drainage was sampled at EPA

Station 8 and shown to be very heavily laden with organics, notably phenolics.

Relative to air pollution from the coal-fired steam plant, substantial abatement could be indicated in the forthcoming period of time. MUCOM, in the 1971 survey of HAAP, indicated that discharge of air pollutants from the boilers amounts to 16,000 lb/day of particulates, 8,000 lb/day of sulfur oxides, plus unknown amounts of other materials.

D. REFUSE ACT PERMIT APPLICATION (RAPP) DATA

Wastewater characteristics submitted by HAAP in May 1971 have been summarized [Table 1]. The summary also includes the total waste loads determined by the U. S. Army Environmental Agency (USAEA) and corresponding RAPP and EPA 1972 survey station numbers.

Of the 13 RAPP outfalls, two are inactive (010 and 011) and three (002, 003, and 004) discharge sludge (from the settling basins within the waterworks) to the River, only once every three or four months. However, to say that the waterworks discharge minimum amounts of coagulated sludge is not necessarily true. In fact, it is highly probable that large amounts of settled sludge are being continuously swept out of the sedimentation basins and onto the waterworks filters. The large majority of these chemical sludges are likely being flushed to the river on a routine daily basis via the unloading and backwashing of the filter beds through RAPP outfall 005 (EPA 1972 Survey Station 6).

RAPP Outfall 013 (EPA Station 2) reflects the addition of some 0.52 mgd wastewater from ASG Industries introduced upstream of HAAP into this "Main Outfall Ditch," which in turn discharges into the South

TABLE 1

OUTFALL CHARACTERISTICS FROM RAPP APPLICATION, HOLSTON ARMY AMMUNITION PLANT - AREA A
KINGSPORT, TENNESSEE

RAPP Outfall Number	EPA Stn. No.[a]	Flow mgd	BOD		COD		SS		NH_3-N		NO_3-N		P-Total	
			mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
001	3,4	4.9	4	163	47	1,909	18	731	-	-	1	40	1	49
002	[b]	0.3	56	140	1,233	3,082	8,112	20,274	-	-	-	-	-	-
003	[b]	0.3	56	140	1,233	3,082	8,112	20,274	-	-	-	-	-	-
004	[b]	0.3	1	4	-	-	22	55	-	-	-	-	-	-
005	6	0.05	5	2	62	26	50	21	-	-	-	-	-	-
006	7	0.01	84	7	276	23	96	8	-	-	-	-	-	-
007	[b]	0.03	5	1	320	80	20	5	-	-	-	-	-	-
008	8	0.0005	-	-	3,600	15	-	-	-	-	-	-	-	-
009[c]	9	-	-	-	-	-	8	4	-	-	-	-	-	-
012	10	1.1	2	20	69	634	85	781	-	-	-	-	-	-
013	2	33.3	34	9,443	60	16,663	93	25,828	10	278	12	333	15	417
TOTALS		40.3		9,920		25,514		67,981		278		373		466
TOTALS FROM USAEHA REPORT[d]		37.6		9,359		13,200		6,060				650		259

a/ These station numbers refer to the 1972 study.
b/ This outfall was not sampled.
c/ Outfalls 010 and 011 are inactive discharges.
d/ This refers to the U.S. Army Environmental Hygiene Agency Report (19 March - 28 June 1971).

Fork of the Holston River. [For EPA 1972 Survey Stations, see Figure 2.]

E. DISCUSSION OF 1972 EPA FINDINGS

During the EPA field sampling survey of 30 November to 3 December 1972 ten wastewater sampling stations were established [Figure 2 and Table 2]. Major wastewater streams include Stations 2, 3, and 4. Stations 2 through 4 and 7 through 10 were manually sampled at two-hr intervals for 72 consecutive hours beginning at 8:00 AM, 30 November. [See Appendix B for description of Sampling Procedure.] These grab samples were composited on an equal volume basis into three 24-hr composite samples. At Station 6 the ion exchange regeneration wastes and filter backwash from the water works were grab sampled at times of discharge. Unnamed Creek (background location) and the plant raw water intake, respectively Stations 1 and 11, were sampled twice daily and composited into daily samples. Data on waste loads from ASG Industries (discharges into open ditch that flows into the main outfall ditch) was obtained with concurrent sampling and were extracted from the results of the 1972 NFIC-D & C survey findings on ASG Industries.

At Stations 2, 3, and 7 through 10 special samples for analyses of oil and grease and of phenolic materials were taken every two hr and continuously composited over a 24 hr period. At Station 6 grab samples for oil and grease analysis were collected twice each day and composited into a daily sample. Temperature, pH, and conductivity were measured each time a sample was collected. [See Appendix C for Methods of Analysis and Sample Preservation.]

EPA flow measurements were made at the following stations:

TABLE 2

EPA SAMPLING STATIONS, HAAP, AREA A, KINGSPORT, TENNESSEE
EPA SURVEY OF 30 NOVEMBER-3 DECEMBER 1972

Survey Station Number	Refuse Act Permit Discharge Number	Type Sample	Station Location
1		2 Grab/Composite	Unnamed Creek, upstream from confluence with HAAP "A" discharge
2	013	Composite	Main Outfall stream, at chain like fence near river bank
3	001	Composite	Process waste outfall at manhole 8, prior to mixing with "manhole 7 wastes" and discharge to South Fork of the Holston River
4	001	Composite	Process waste outfall at manhole 7, prior to mixing with "manhole 8 wastes" and discharge to the river.
6	005	Grabs	Zeolite regeneration wastes and backwash from waterworks
7	006	Composite	Process waste outfall to the river originating from main tank farm
8	008	Composite	Leached wastes from area of tar tanks on discharge line close to the river bank
9	009	Composite	Floor drainage and steam-plant effluent at manhole on outfall.
10	012	Composite	Discharge from steam plant, principally an ash pit overflow, together with pump gland drainage originating from (water) pump house
11		2 Grab/Composite	Raw water intake into water works

1. Stations 3, 4, 7 - measured every 2 hr with a Marsh-McBirney electromagnetic water-current meter.
2. Stations 1 and 2 - gaged several times daily and rating curves were established.
3) Station 8 - flow recorder was installed for continuous measurement.

Flow data for remaining sampling stations were extracted from HAAP records and/or generally compiled from special Army studies.

The EPA 1972 survey revealed a total (net) wastewater discharge from HAAP, Area A, of 43.3 mgd, but the 43.3 mgd does not include ASG Industrial Wastewater discharges and the natural flow in Unnamed Creek that contribute to overall flows in the "Main Outfall Ditch." The RAPP applications reported a total water intake of 65 mgd pumped from the South Fork of the Holston River. Because the USAEHA 1971 waste survey showed only 37.6 mgd of wastewaters being discharged from Area A, HDC decided to measure, during June to July 1972, the total plant intake water with pitot tubes during June-July, 1971, and consequently the survey showed an average intake flow of 48.7 mgd. Of course the EPA figure of 43.3 mgd reflects spent waters leaving HAAP, Area A, and does not take into account water lost in product, evaporation and steam losses, and some 0.35 mgd of pumphouse trash rack wastewater.

The complex nature of pollutants contained in the wastewater from Areas A and B, presented unusual difficulty to EPA personnel who conducted the analyses. It is likely that the important waste characterization parameters of BOD, COD, and TOC were affected in varying degree

by the kind of wastewaters encountered. Many HAAP wastes are relatively non-biodegradable and are potentially toxic to biological life, hence yielding comparatively low BOD values. The presence of acetic acid, straight-chain aliphatics and aromatic hydrocarbons all of which are prevalent in HAAP wastes, are relatively resistant to COD measurement. Survey results for TOC were noted as exceptionally low relative to the BOD and COD values, leading one to suspect some interference in these determinations. Procedural difficulties were also experienced in undertaking the complex organic analyses. Refined analytical methods and possibly some research on modified analytical techniques, directed specifically to HAAP-type wastewaters, would seem advisable. Results for BOD, COD, and TOC, obtained from the EPA 1972 sampling survey, are considered to represent the near minimum values.

Specific water and wastewater sampling results obtained from the 30 November to 3 December 1972 EPA survey of the HAAP A installation are discussed as follows: [The summary of analytical data from the EPA survey is presented in Table 3.]

Unnamed Creek At Station 1

This creek had a natural average flow of 0.69 mgd, and the water quality was similar to that found in the South Fork of the Holston River (as compared to plant water intake at Station 11) except for slight increases in values of BOD and conductivity.

Main Outfall From HAAP, Area A, Station 2

The main outfall from Station 2 collects the majority of spent

TABLE 3

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT AREA A
KINGSPORT, TENNESSEE
1-3 DECEMBER 1972

Station Number	1		2		3		4	
Station Description[a]	Unnamed Creek Upstream (RM 142.15/4.04)		Main Outfall Ditch (RM 142.15/4.04)		Process Waste Outfall (RM 142.15/4.30)		Process Waste and Cooling Water Outfall (RM 142.15/4.30)	
Parameter[b]	Range	Average	Range	Average	Range	Average	Range	Average
Flow (mgd)	0.52-0.96	0.69	33.5-33.7	33.6	3.97-5.40	4.65	3.88-4.96	4.40
pH (standard units), range	6.9-7.0		6.2-7.6		6.2-7.4		6.1-7.5	
Temperature (°C), range	5.5-6.0		18.0-20.0		14.0-16.0		14.0-17.0	
Conductivity (umhos/cm), range	320-480		160-300		200-350		180-360	
BOD	2.4-5.8	3.80	56-71	65	20-75	41	4.6-12	8.5
BOD (lb/day)		24		18,800		1,500		320
COD			64-66	65				
TOC	6-8	6.7	6-11	8.7	4-29	14		
Total Solids	193-326	276	133-168	147	123-138	132	125-211	160
Suspended Solids	10-45	29	3-21	9.6	4-14	9	8-22	15
Suspended Solids (lb/day)		190		2,700		350		520
Total Kjeldahl Nitrogen-N	N.D.[c]		<0.5-0.5	<0.5	<0.5-0.5	<0.5	<0.5-0.6	<0.5
NH_3-N	N.D.		N.D.		N.D.		N.D.	
$NO_2 + NO_3$-N	0.5-1.8	0.9	0.8-1.9	1.3	0.8-1.0	0.9	1.0[d]	1.0
$NO_2 + NO_3$-N (lb/day)		6.30		354		35.0		36.7
Total Phosphorus-P	0.28-0.67	0.45	0.19-0.22	0.21	0.18-0.20	0.19	0.12-0.14	0.15
Total Phosphorus-P (lb/day)		2.80		57.9		7.24		5.52
Oil and Grease	2-3	2			<1-2	<1		
Phenols	N.D.		N.D.		N.D.		N.D.	

TABLE 3 (Cont.)

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT AREA A
KINGSPORT, TENNESSEE
1-3 DECEMBER 1972

Station Number	6		7		8		9	
Station Description[a]	Filter Plant Backwash (RM 142.15/4.25)		Tank Farm Wastes (RM 142.15/4.24)		Tar Tank Area (RM 142.15/4.20)		Steam Plant Effluent (RM 142.15/4.19)	
Parameter[b]	Range	Average	Range	Average	Range	Average	Range	Average
Flow (mgd)		0.04[c]		0.18	0.005-0.008	0.007		0.69[c]
pH (standard units), range	6.4-7.1		4.5-7.6		5.8-8.1		6.7-11.2	
Temperature (°C), range	9.5-10.3		14.0-24.0		13.0-65.0		15.0-21.5	
Conductivity (umhos/cm), range	280-360		200-460		500-26,000		220-640	
BOD	22-36	29	20-32	26	>800->2,700	>2,030	6.9-7.2	7.1
BOD (lb/day)		9.7		37		>122		40
COD					4,800-10,600	7,957		
TOC	7-18	12.5	3-7	5	1,300-2,800	2,130	3-8	5
Total Solids	229-475	352	72-268	173	2,400-5,300	4,020	196-202	199
Suspended Solids	118-236	177	7-57	25	64-98	84	15-47	27
Suspended Solids (lb/day)		59		29		4.5		160
Oil and Grease			<1-2	1	31-89	63	<1-3	2
Phenols	<0.01-0.04	0.023			1,100-5,800	3,600	1.3-5.0	2.1
Phenolics (lb/day)						202		12.1

TABLE 3 (Cont.)

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT AREA A
KINGSPORT, TENNESSEE
1-3 DECEMBER 1972

Station Number	10		11	
Station Description[a/]	Sluice Pit Outfall (RM 142.15/4.10)		Raw Water Intake (RM 142.15/4.08)	
Parameter[b/]	Range	Average	Range	Average
Flow (mgd)		1.0[e/]		48.7[e/]
pH (standard units), range	6.5-8.2		6.1-6.9	
Temperature (°C), range	27.5-38.0		9.0-10.0	
Conductivity (µmhos/cm), range	150-320		240-280	
BOD	2.9-3.9	3.4	1.0-1.4	1.1
BOD (lb/day)		28		460
COD	57[f/]	57		
TOC	8-17	11	2-4	3.3
Total Solids	161-173	167	125-143	134
Suspended Solids	16-36	29	6-35	22
Suspended Solids (lb/day)		240		8,800
Total Kjeldahl Nitrogen-N			<0.5-0.5	<0.5
NH_3-N			N.D[d/]	
$NO_2 + NO_3$-N			1.0[d/]	1.0
$NO_2 + NO_3$-N (lb/day)				406
Total Phosphorus-P			0.06-0.22	0.12
Total Phosphorus-P (lb/day)				47.4
Oil and Grease	<1-2	<1		

a/ See Table 2 for station description.
b/ All values reported as mg/l, except where otherwise specified.
c/ N.D. - None Detected.
d/ All values are the same.
e/ The flow was determined from RAPP application.
f/ This is based on one value.

cooling- and process-water flows from the Area A manufacturing facilities. An average flow of 33.6 mgd was observed within the large drainway that includes some 0.52 mgd wastewater flow contributed by the ASG Industries and the respective flow of Unnamed Creek [Figure 2]. The creek carries a negligible waste load into the drainway, but the ASG pollution loads are equivalent to 3,600 lb/day suspended solids added to the upper section of the Main Outfall. However, some solids rapidly settle out, both within the open drainage ditch and within parts of the Main Outfall. Near its terminus point at Station 2 it was found to be conveying average loads of 18,800 lb/day BOD; 18,200 lb/day COD; and 2,700 lb/day suspended solids directly into the South Fork of the Holston River. Using any criterion of measurement, these are very large waste loads. More than 90 percent of the total BOD and COD loads discharged from Area A were found in this single outfall. Surprisingly so, at least during the three-day survey, no phenolic materials were detected at this location, and nutrient levels were fairly similar to background waters. No detectable amounts of heavy metals were found at Station 2. However, a number of metals sources exist within the HAAP A complex, especially from the sludge-heater system and corrosion of the aezotropic distillation columns (Buildings 2 and 6). These could contribute to a metals problem. Using fathead minnows as the test fish species, bioassay studies were conducted on a 24-hr composite sample of the Main Outfall, the 96-hr TL_m (50 percent fish kill) obtained from static bioassays was 56.0 percent of the wastewater concentration. When one considers the magnitude of flow at Station 2, these toxicity results are highly significant as will be explained later in this report.

Two Process Waste Outfalls, Stations 3 and 4

Outfalls at Stations 3 and 4 are located in a vertical plane one above the other and eventually join together prior to their combined discharge into the South Fork of the Holston River. These outfalls contain various spent process and cooling waters from the producer gas plant (Building 10), and the acetic anhydride manufacturing areas (Buildings 7 and 20). These two drains comprise the second largest BOD load from Area A into the South Fork of the Holston River. The combined discharge was about 9 mgd containing 1,820 lb/day BOD, 680 lb/day TOC, and 870 lb/day of suspended solids.

Outfall At Station 6

This outfall originates from the HAAP A waterworks and carries ion exchange regeneration wastes and sludges from filter bed backwashing. This outfall discharges on an irregular schedule. Previous data (from the U.S. Army Environmental Hygiene Agency) indicate 40,000 gpd being discharged via this outfall. A wide discrepancy exists between this flow figure and the 1-million-gpw figure of waterworks sludge mentioned in the November 1971 MUCOM report for HAAP A. Waste loads from this outfall, at least as measured by the EPA Survey, were relatively minimal. Still remaining are questions as to the frequency and magnitude of sludge loads released from the other three waterworks outfalls. The dumping of water treatment sludges into receiving streams is unsatisfactory.

Tank Farm Area Drainage, Station 7

Drainage from the main tank farm area (principally acetic acid storage) averaged 188,000 gpd containing mean BOD and suspended solids

loads of 37 lb/day and 38 lb/day, respectively. However the pH values were somewhat erratic, ranging from 4.5 to 7.6. Spills and inadvertant waste releases associated with HAAP chemical storage areas are treated later in this report.

Tar Tank Storage Area, Station 8

The leachate and drainage accruing from the grounds around the tar tank storage area, measured at Station 8, amounted to about 7,000 gpd and was categorized as a noxious and heavy organic-laden waste stream. Average BOD, COD, and TOC values were, respectively, greater than 2,030 mg/l, 7,960 mg/l, and 2,130 mg/l. Concentration of phenolics was found to be 3,600 mg/l. This discharge, upon entering the South Fork of the Holston River, caused an intense reddish coloration, detectable about 100 yd into the main river. Waste loads in this outfall approximated 460 lb/day COD and 200 lb/day of phenolics. Flow-through bioassay studies were conducted on this waste stream. Results, with fathead minnows as the test species, disclosed that a 0.17 percent waste concentration would kill one-half of the test fish within 96 hr. This toxicity is within the same range as some of the more potent pesticides.

Steam Power Plant, Station 9

Boiler blowdown and floor and miscellaneous drainage from the steam power plant, as measured at Station 9, yielded an average discharge of 0.69 mgd, containing BOD, suspended solids, and phenolics loads amounting to 40 lb/day, 160 lb/day and 12 lb/day, respectively. The phenolics are probably attributable to coal tar and/or coal used as fuel for the boilers.

Ash Pit Overflow and Pump Seepage, Station 10

Ash pit overflow (originating from the steam plant), together with packing gland seepage from pumps in the water intake house, were measured at Station 10. HAAP recorded an average flow of 1.0 mgd for Station 10 during the EPA survey. Sluice pits used for settling the ash slurry (from the steam plant) represent the only external waste treatment presently found in Area A. Waste loads being discharged to the South Fork of the Holston River approximated 240 lb/day suspended solids and 470 lb/day COD. Oil and grease values were negligible. The EPA survey results suggest that unreported waste sources may be contributing to this outfall.

Raw Water Supply, Station 11

The raw water supply for Area A pumped from the South Fork of the Holston River, Station 11, was approximately 46.7 mgd, according to special HDC pitot tube studies that have been partially substantiated by EPA and USAEHA calculations. The incoming river water was reported to be of good quality with a BOD of 1.1 mg/l and with 22 mg/l of suspended solids. Nutrient levels were low with the exception of 1.0 mg/l of nitrite-nitrate, indicating some enrichment from upstream sources.

A summation of wastewater loads from Area A, for the period of the EPA survey, discloses that 20,300 lb/day BOD, and 4,060 lb/day of suspended solids were collectively being discharged to the South Fork of the Holston River. Included in the suspended solids load was 3,600 lb/day being contributed by ASG Industries to the upper section of the Main HAAP Outfall, although much of this load actually settled

out in the open (ASG) ditch before reaching the main outfall. As mentioned previously in this report, the mean total volume of wastewater discharge from the overall HAAP Area A was 43.3 mgd. This figure excludes the flow contribution from Unnamed Creek and the ASG wastewaters.

Comparison of the 1972 EPA summary data to the 1971 USAEHA studies and the RAPP application data is as follows:

WASTEWATER VALUES - SUM OF ALL OUTFALLS*

	USAEHA	RAPP	1972 EPA
Flow (mgd)	37.6	40.3	43.3
BOD (lb/day)	9,360	9,920	20,300
COD (lb/day)	13,200	25,500	19,100 (approximately)
SS (lb/day)	6,060	68,000	4,060

By comparing the RAPP data to the EPA 1972 results, it is seen that only the flow values are in reasonable agreements. Differences between the 1972 results and the previous USAEHA data series are especially critical because the latter figures were supposed to provide specific engineering design criteria for upcoming HAAP A waste treatment processes. USAEHA loadings for BOD and COD are about one-half the 1972 EPA loads. Although many other questions concerning MUCOM's approach and the waste-abatement plans for HAAP remain unanswered, the differences expressed herein could alone greatly alter the expected performance of the planned aeration basins at HAAP A. Design specifications that apparently are being employed at the present time will fall far short of attaining effluent limitations predicated upon "best practicable control technology currently available."

* Production levels have remained constant.

F. FUTURE WASTE-ABATEMENT SCHEDULE

The HAAP pollution-abatement plans comprise part of the AMC Modernization Program, subject to Congressional appropriation. These projects under the Military Construction appropriations are expected to abate serious air and water pollution problems at military installations as addressed by Executive Order 11507. Furthermore, under the "Federal Water Pollution Control Act Amendments of 1972," Section 313, all Federal facilities having discharge or runoff of pollutants, are now instructed to comply with Federal, State, interstate and local requirements regarding control and abatement of pollution to the same extent that any "person" (as rigorously defined in the Act) is subject to the requirements of the Act.

Pertinent sections of the Act that would seem to have application to Federal facilities and Army munitions manufacturing plants are Sections 301 and 302 dealing with Best Practicable Control Technology required by 1 July 1977, and Best Available Technology required by 1 July 1983, both of which are directed to the national goal of eliminating the discharge of all pollutants. Additionally, Section 306 and 307 deal with standards of performance to be established through best available demonstrated control technology for new pollution sources and the establishment of toxic and pretreatment effluent standards, respectively.

However, under Section 313 of the Act, the President can exempt any Federal facility effluent source if it is in the paramount interest of the United States to do so; no such exemptions shall be granted in waiving requirements under Sections 306 and 307 of the Act. It is also

stated that no such exemptions shall be granted because of a lack of appropriations, unless the President has specifically requested such appropriation as part of the budgetary process, and Congress has failed to make available such requested appropriation.

The November 1971 MUCOM report for HAAP specifically states that HAAP has a planned program for abatement of each of its major pollutants; the program is being implemented as rapidly as Federal funding permits. As of the end of 1971, the report cites that progress in planning has not been manifested in construction. It appeared doubtful that any significant construction would be accomplished prior to December 1972. We note the pilot aeration lagoon which is the first major item of construction at Area A, and which was scheduled for completion in December 1972, has not, at this date, been actually completed.

To gain the necessary background in understanding the envisioned pollution abatement plans at HAAP one must be aware of the preceeding and current criteria and standards under which these plans are being formulated. Earlier standards/criteria include the State of Tennessee air and water quality requirements and the CERL engineering design criteria. An Army report, *"Effluent and Ambient Air and Water Quality Standards and Regulations Applicable to Army Ammunition Plants"* has been recently completed, but copies have not yet been received. The most extensive and perhaps the most important set of criteria covering Army munitions manufacturing plants is that incorporated under the APSA Guidelines that give proposed air and water quality standards for both effluents and boundary conditions. These Guidelines are more complete

and as limiting as any specific set of State or Federal standards, and according to the Army, can be applied universally across the entire MUCOM munitions manufacturing complex. MUCOM, in a recent Senior Scientist Steering Group Briefing of February 1973, compared future waste abatement performance expected at its various Government Owned-Company Operated (GOCO) facilities, specifically with the APSA load limits.

Based upon this understanding, the APSA Guidelines should be judged to be the controlling criteria for waste-abatement plans and activities at most Army munitions facilities. EPA Effluent Limitations for munitions manufacturing, if developed for purposes of Sections 301 and 304 of the Federal Water Pollution Control Act Amendments of 1972, will rely heavily upon the APSA Guidelines. The APSA Regulations are enumerated in this report [Table 4] as are the MUCOM proposed schedules for identified pollution-abatement projects at HAAP, Area A [Table 5]. No funds have been appropriated beyond Fiscal Year 1973. During the EPA survey, construction was in progress on a 4.5 million gal. pilot aerated lagoon (Phase I Pond) for HAAP A.

In the case of the Holston Army Ammunition Plant, the effluent limitations should be controlled by Water Quality Standards which call for a minimum DO content of 5 mg/l in both the South Fork and the Holston River. These limitations are shown in Table 6.

Relative to the overall MUCOM pollution-abatement schedule for HAAP — based upon a preliminary analysis of the schedule, a number of potential deficiencies in the schedule are apparent [See the "remarks" column in Table 5]. Additional information is necessary to ascertain,

TABLE 4

DEPARTMENT OF THE ARMY
AMMUNITION PROCUREMENT & SUPPLY AGENCY
PROPOSED GUIDELINES

APSA Regulation
Number 11-13

Proposed Air Quality Standards

Design and Operating Standards (Proposed)

Pollutant	Boundary Standard (ppm)	Stack Emission Standard (ppm)
Acidity	12ug/M^3(1)	50mg/M^3
Ammonia	0.15	100.
Carbon Monoxide	0.15	....
Hydrocarbons	0.20	200.
Hydrogen Sulfide	0.02(5)	100.
Lead	0.5ug/M^3(4)	....
Nitrogen Oxides (a)	0.10(2)	200.
Oxidants	0.04	....
Ozone	0.03	....
Particulates	80ug/M^3(4)	200mg/M^3*
Particulates, Incinerator	80ug/M^3(4)	450mg/M^3**
Sulfur Dioxide, Power Plant	0.04(3)	500
Sulfur Dioxide, Acid Plant	0.04(3)	200

(1) Maximum value not to be exceeded more than 1% of the hours per year.
(2) Average value for measurable limits over a 1 hour period is not to be exceeded more than 1.0 percent of the time over a three month period.
(3) Maximum value not over 1% of the time in a 24-hour sample period.
(4) Maximum value for any 24-hour sample period.
(5) Average value for ½ hour not to be exceeded more than twice a year.

* This value is calculated from figure 1-1 of AR 11-21.
** This value is calculated from value given in paragraph 1-7C.(2) of AR 11-21.

(a) Nitrogen oxides include NO + NO_2.

TABLE 4 (Cont.)

APSA Regulation Number 11-11

Proposed Water Quality Standards

Design and Operating Standards - Ionic Materials (Proposed)

Pollutant	Effluent Standard ppm	Boundary Standard ppm
Aluminum	1.0	0.1
Ammonia	0.1	.01
Antimony*	0.05	0.01
Arsenic*	0.05	0.01
Barium*	1.0	0.1
Beryllium	0.05	0.01
Bicarbonate	35	35
Bismuth*	1.0	0.5
Boron	1.0	0.1
Bromide	1.0	0.5
Calcium	100	50
Cadmium*	0.01	0.01
Chloride	150	25
Cesium	1.0	0.1
Chromate	0.05	0.05
Chromium	1.0	0.1
Cobalt*	1.0	0.1
Copper*	0.2	0.02
Cyanide	.025	0.01
Floride	1.0	0.7
Germanium*	.5	0.05
Iron	0.3	0.05
Lanthanum	1.0	0.1
Lead*	0.05	.01
Lithium	0.5	0.1
Magnesium	30	15
Manganese*	0.05	0.01
Mercury	0.01	0.01
Molybdenum*	1.0	0.1
Nickel*	1.0	0.1
Nitrate	5.0	0.5
Phosphate	0.5	0.05
Platinum*	.5	.05
Potassium	10	10
Radioactivity, Total	**	**
Selenium	0.01	0.01
Silicon Oxide	6	6
Silver*	0.05	0.01
Sodium	100	10-60
Strontium*	10	.1
Sulfate	200	50
Sulfite	2.0	0.1
Tantalum*	1.0	0.1
Tellurium	0.1	0.1
Thorium*	1.0	0.1
Tin*	1.0	0.1
Titanium*	1.0	0.1
Tungsten*	1.0	0.1
Uranium*	1.0	0.1
Vanadium*	0.5	0.1
Zinc	0.5	.05
Zironium*	1.0	0.1
Total Heavy Metal	5.0	5.0

* Heavy Metal

** Radioactive - gross beta activity in the known absence of Strontium 90 and alpha emitters not to exceed 1000 micromicrocuries per liter at any time. "Absence of" is defined as not more than 10 pico curies of Strontium 90 and 3 pico curies of alpha radiation

TABLE 4 (Cont.)

Design and Operating Standards - Non Ionic Materials (Proposed)

Pollutant	Effluent Standard ppm	Boundary Standard ppm
Color (Color Units)*	3-30	3-30
Maximum Temperature (^{o}F)	a	90
Oil (ppm)	15	No Visible Oil on Water Surface
Oxygen Dissolved Minimum Value (ppm)	5	5
Biological Oxygen Demand (ppm)	15.0	2.0
Chemical Oxygen Demand (ppm)	20.0	2.0
Total Organic Carbon (ppm)	30.0	3.0
Phenols (ppb)	10	10
pH (pH Units)	6.0-8.5	6.0-8.5
Solids, Dissolved (ppm)	500	200
Solids, Suspended (ppm)	25	25
Insecticides Chlorinated Hydrocarbons (ppb)	0	0
Insecticides Organic Phosphorous (ppb)	0.5	0.1
Insecticides Carbamate (ppb)	0.5	0.1
Herbicides (ppb)	0.1	0.1
Bacteria-Monthly Average (No./100 ml)-% of samples (Coliform count)		(5000)-20 (2000)-5
TNT and Nitrobodies (ppm)	0.5	0.3

ppb - parts per billion
ppm - parts per million

a state water ambient temperature shall not be increased for more than $5^{o}F$, with the hourly temperature change of the state water not to exceed $1^{o}F$.

* color units are based on platinum-cobalt standard

TABLE 5

PROPOSED POLLUTION-ABATEMENT SCHEDULE
HAAP, AREA A - KINGSPORT, TENNESSEE[a/]

Item	Funding FY	Estimated Completion FY	Remarks
		W A T E R	
Aerated Lagoon, Pilot Plant only (Phase I)	70	72	See comments on expected performance, this report but are presently not expected to meet water quality standards requirements
Aerated Lagoon, Full Scale (Phase II)	73	76	Design and performance criteria not known by EPA
Separation of uncontaminated cooling water from process waters			Specified in 1971 MUCOM report but no real followup evident in pollution abatement schedule
Tank-Farm Dike System	72	74	Spill Containment dikes with routing of spilled materials back to industrial wastewater treatment system (See other comments in this report.)
Water- and Air-Pollution Monitoring Systems	73	75	
Waterworks sludge settling and land disposal	72	74	Sludge to be disposed of onto Area B grounds. Because supernatants are designed to enter lagoon, full objectives will not be met until FY 76
Boiler Blowdown to Aeration Lagoon	72	74	Lagoon will not be completed until FY 76, effectively causing delay in project objective until 76, rather than 74
Pumphouse Trash Disposal	72	74	Further details sought

TABLE 5 (Cont.)

PROPOSED POLLUTION-ABATEMENT SCHEDULE
HAAP, AREA A - KINGSPORT, TENNESSEE[a/]

Item	Funding FY	Estimated Completion FY	Remarks
Replacement of distillation columns serving sludge-heater sludges in order to combat metals problem in effluents, Bldg. 2			Plans not known
Ash pit waters, Bldg. 8	73	75	Plans not known
Flash column improvements, Bldgs. 2 and 6, to improve propyl acetate recovery	73	74	Further details sought
Control and/or elimination of drainage from the tar tank area			Indicated as essential by EPA survey
Possible substitution of surface condenser in lieu of barometric condenser(s), Bldgs. 7 and 20			Means of reducing water pollution
Alternative means of handling and disposing of ball mill and sludge-heater sludges			Likely a major waste source that should be handled and disposed of in slurry or semi-solids form
		A I R	
Removal of methyl nitrate, and recovery of volatile gases from azeotropic stills, Bldgs. 2 and/or 6	73	76(?)	In feasibility stage only. Control for Bldg. 6 apparently unplanned
Precipitators for the Pulverized Coal Boiler (Area A?)	70	73	Further details sought

TABLE 5 (Cont.)

PROPOSED POLLUTION-ABATEMENT SCHEDULE
HAAP, AREA A - KINGSPORT, TENNESSEE[a/]

Item	Funding FY	Estimated Completion FY	Remarks
Precipitators on Boilers (Not known if Area A and/or B)	73	75	Further details sought
Control and treatment of noxious vent gases from anydride manufacturing (Bldgs. 7 and 20)			Determined by Army as a major air-pollution source
Vents from producer gas building			Cited in USAEHA report
Vents from Bldg. 6, anhydride refining operations			Cited in USAEHA report
NO_x control and treatment			Both NO_x and SO_x abatement technology being studied by MUCOM on an overall facilities basis. Prototype units now in development stage including molecular sieve for NO_x which is fairly advanced. NO_x and SO_x problems considered reasonably critical.
SO_x control and treatment			
S O L I D S[b/]			
Trash Disposal Incinerators (to serve bouth Areas A and B?)	72	74	Further details sought

a/ Other items have been cited in MUCOM, USAEHA, and HAAP reports, but these items are either ambiguous or do not have a demonstrated impact on waste-abatement progress.

b/ Open burning procedures for trash, debris, packaging materials spent process and explosives materials, etc. continue to represent current practices. Even though this report has not emphasized the problems of open burning and solid waste disposal, air pollution from open burning has been severe in many instances. Advanced technology is urgently needed.

TABLE 6

STATE OF TENNESSEE EFFLUENT LIMITATIONS*
FOR HAAP-AREAS A AND B

Parameter	Effluent Limitations, lb/day
HAAP A	
BOD	1,050
HAAP B	
BOD	1,430
TKN	76
TN	620
NH_3	76
NO_3	556

* These are effluent limitations required to maintain a DO of 5 mg/l in the South Fork and Holston Rivers.

step by step, planned activity to be undertaken by HAAP. Certain essential abatement items have not been either adequately described or incorporated into the plans or appropriated to date under the MUCOM schedule. Most importantly, no method seems available whereby the MUCOM technology implementation schedule could be translated into a concise statement as whether and when the effluent limitations can be met for the HAAP installation. Further coordination and detailed review of the HAAP waste abatement plans are needed between MUCOM, HAAP and the Region IV, EPA Enforcement and Federal Activities Program Offices.

There are two aspects of the HAAP biological treatment systems that pose serious concern about the success of this approach and that warrant much more attention. Past design criteria for the aeration lagoons have been liberal, and the effluent limits as specified will not meet the effluent limitations. The biological systems as now described to the EPA are not consistent with "best practicable control technology currently available." The other aspect deals with the kinds and amounts of wastes being treated and their inherent impact upon the efficiency of a biological system. If it is assumed that future HAAP A activities will almost necessarily include the strict segregation of cooling waters from process flows (the latter to receive treatment), then the (remaining) 0.6 to 4.0 mgd process wastewaters may be more adaptable to chemical/physical treatment than to biological treatment, as now being planned by HAAP.

Increased recycling, re-use, and recovery of process flows together with strict segregation of cooling waters could hold the total process

wastewaters at Area A down to 1 mgd, or less. Available data strongly suggest that these process effluents per se, are extremely strong in COD, complex organics, toxicity, and, possibly, metals content. Unfortunately, proper data do not exist relative to the characteristics of individual process flows; this is partly because the cooling and process flows are now combined within the existing sewer system inside each manufacturing building. Based upon similar experiences and with the pieces of data now on hand, the implied risk in using biological treatment with the HAAP wastes is abnormally high. Mixing, with additional cooling water, and enlarging the size of the biological units are not likely to substantially improve the creditability and performance of the biological approach. Characterization of the separate process flows could serve to clarify this most important issue.

VII. HOLSTON ARMY AMMUNITION PLANT-AREA B

A. GENERAL

Area B, the nitric acid and explosives manufacturing facility, is situated on 6,370 acres immediately downstream of the confluence of the North and South Forks of the Holston River [Figure 1] and approximately 6 miles west of the City of Kingsport and Area A.

Major processes at Area B, include nitric acid and ammonium nitrate production; the preparation, manufacturing, and packaging of various explosives; and the recovery of waste acetic acid for shipment to Area A.

Area B was studied from 12 through 15 December 1972. Mr. Robert Banner, Jr., chemical engineer at HDC, provided information and assistance during the industrial surveys.

B. UTILITIES AND WATER SUPPLY

Area B purchases its electricity and potable water (0.2 mgd) from the City of Kingsport. HAAP records show that about 84.4 mgd of water is pumped through an intake screen from the Holston River at two pumping stations. About 14.5 mgd of this is treated by flocculation, sedimentation, and filtration to produce process water; about 0.75 mgd of this is deionized for use as boiler-feed water.

Wastewaters discharged to the river totaled 84.6 mgd. A natural stream entering the plant grounds (Arnotts Branch) contributed 11.4 mgd, thus producing a net waste flow of 73.2 mgd.

Only one of the two water filtration plants was on stream at the time of the EPA survey. The wastewater from cleaning the intake screens,

backwashing the filters, and desludging the sedimentation basins enters the river at Station 25. Pollution-abatement plans at the water treatment facility call for land disposal of material removed from the intake screens and for continuous sedimentation of filter backwash water with solids going to thickeners, followed by sand bed drying and ultimate disposal at a landfill. The sedimentation basins treating the main flow will be converted to continuous sludge removal. Sludge from these basins will also be thickened, dried on sand beds and disposal of at a landfill.

Wastewaters from the steam-production buildings consist of boiler blowdown; ion exchanger backwash, regeneration wastes, and rinse water; cinder decant water; condensate and cooling water. These wastes are discharged through the main outfall, at Station 33. Present abatement plans call for these wastes to be diverted to the industrial waste treatment facility.

Sanitary wastes from Area B and from a few homes in the immediate area are treated at a secondary treatment plant on the grounds, consisting of primary sedimentation, trickling filters, secondary sedimentation and chlorination. The adequately treated waste is discharged to the Holston River at Station 26.

C. PROCESS OPERATIONS AND WASTE SOURCES

The main activities at Area B include production and concentration of nitric acid; production of ammonium nitrate; production, purification, and packaging of explosives; and the recovery of dilute acetic acid, which is then returned to Area A.

Nitric acid is produced by the oxidation of anhydrous ammonia to

nitrogen oxide that, when dissolved in water, produces dilute nitric acid. It is concentrated to 99 percent by extractive distillation with magnesium nitrate. The process wastewaters from these operations include ammonia, nitric acid, the nitrite ion, and a small amount of oil from the compressors used in the ammonia oxidation process. These process wastes and the cooling water from the processes are discharged at Station 33 [Figure 4].

The concentrated nitric acid is, together with anhydrous ammonia, employed in the production of a nitric acid-ammonium nitrate solution, an intermediate step in this manufacturing process. Essentially all of the waste flow from the operation is cooling water, low in contamination. It was included in Station No. 33.

Manufacture of the explosive compounds takes place in a series of facilities which receive glacial acetic acid (conveyed in tank cars) and acetic anhydride from Area A, nitric acid and the ammonium nitrate-nitric acid solution (conveyed in tank cars) from Area B, and other materials purchased for use. These materials include hexamine (hexamethylene tetramine), wax, TNT (trinitrotoluene), lacquer and several desensitizing agents.

In the "Preparation" complex [Figure 5] a number of operations are carried out. Hexamine is dissolved in glacial acetic acid. The ammonium nitrate-nitric acid solution is stored for use elsewhere. Lacquer mixtures for use later in the process are also prepared. Waste flows from the Preparation complex include spilled hexamine and negligible amounts

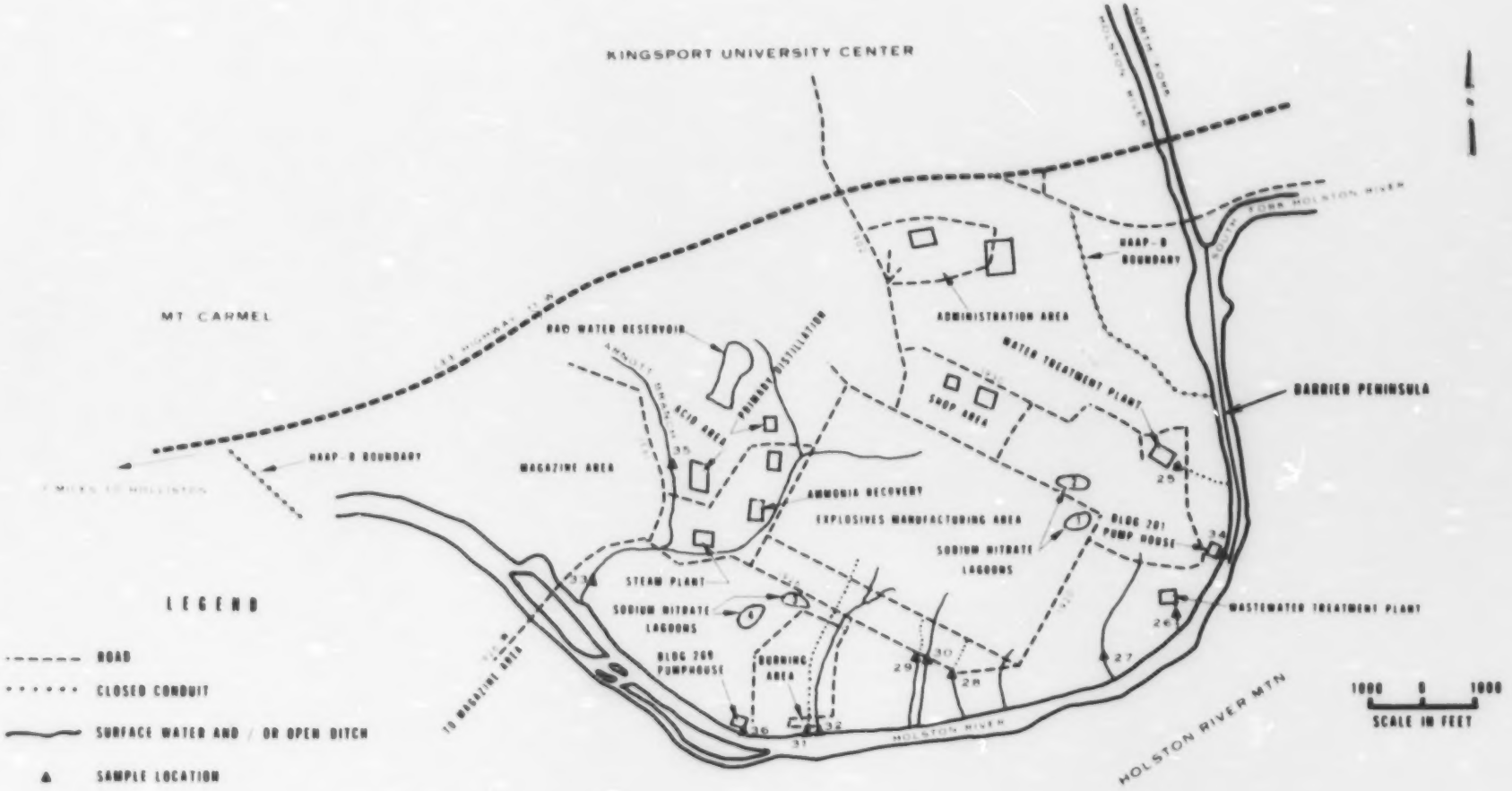

Figure 4. Sampling Stations Holston Army Ammunition Plant - B
Kingsport, Tennessee

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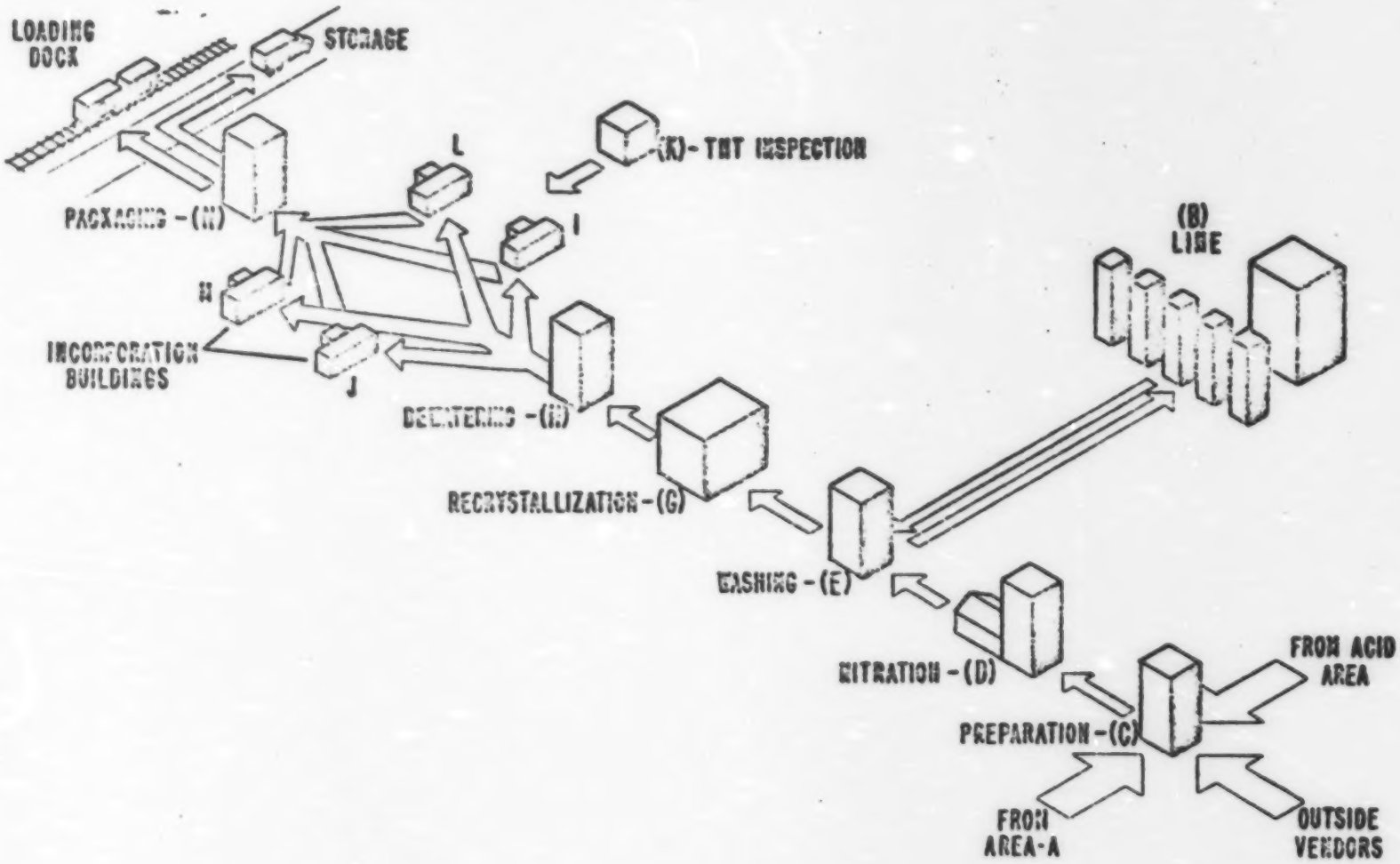

Figure 5. SCHEMATIC OF EXPLOSIVE PRODUCTION LINE-AREA B, HOLSTON ARMY AMMUNITION PLANT

Courtesy of MTD, Picatinny Arsenal, Dover, N.J.
Taken from W. Heidelberger Report, Nov. 1971.

of acids and other organics. The wastes from these operations were monitored at Stations 28 and 33.

The hexamine-acetic acid solution is pumped to the "Nitration" operation where the hexamine solution is batch nitrated, with the nitric acid-ammonium nitrate solution, to produce crude RDX ($C_3H_6O_6N_6$) or HMX ($C_4H_8O_8N_8$). Acetic acid and acetic anhydride are also added to the reaction vessel. After initial reaction, the mixture is "aged" and then diluted with wastewater from a vent scrubber on the reaction vessel plus other water from a later washing operation. Contaminants in the explosive mixture at this point include acetic acid, ammonia, nitric acid, and numerous aliphatic and cyclic nitro compounds. Contaminated waste streams from the nitration operation are routed through a catch basin in route to the industrial sewer. The waste flows from this operation include cooling water, condensate, agitator seal water, and floor and equipment washdown water. The contaminants include RDX, HMX, acetic acid, and other materials, mostly from leaks and spills in the nitration operation. The flows from the various nitration facilities were monitored at Stations 28, 29, 31 and 33.

The crude RDX or HMX slurry is pumped from "Nitration" to "Washing." Another source of crude explosive is the "B-line" (to be discussed later). In the washing operation, the explosive is filtered, washed, and reslurried for transfer to another series of processing areas. The filtrate and most of the water used to wash the explosive, at a 60 percent acid concentration, are sent to the "B-line" area for recovery of acetic acid and ammonia. The final dilute filtrate is sent to "Nitration" to be used

as dilution water. The washed explosive is reslurried and pumped to another complex for further processing. The contaminated wastes, containing explosives, acetic acid, nitric acid, and other components of the mixture, pass through baffled catch basins before entering the industrial sewer. They were sampled at Stations 28, 29, 31 and 33.

The washed explosive slurry is then pumped to the "Recrystallization" facilities, which, in addition to recrystallization, accomplish dewatering and compounding of special-purpose explosives. The slurry is pumped into dissolvers containing solvents. Depending upon the type of crystal desired in the explosive, the solvents used can be cyclohexanone, acetone, or toluene. After dissolution, the solvent is distilled off, condensed, and re-used. The batch is then cooled and either dewatered in the crystallization process or sent on as a slurry to the "Dewatering" operation. The wastewaters -- mostly cooling water, seal water, and condensate, were sampled at Stations 28, 29, 30, 31 and 32. The contaminated flows pass through baffled catch basins before being introduced to the sewers. The contaminants include solvents, explosives, lacquers, and other compounding agents.

The explosive slurry or dewatered explosive is then sent to "Dewatering" for grinding or dewatering and grinding. All grinding is done in a water slurry. In order to remove explosives, which are later sent to receiving tanks, the filtrate is settled, and the overflow water drains to a catch basin and then to the sewer. The ground, dewatered explosives (as a wet cake) are then sent to another series of facilities for compounding. The wastewaters, containing explosives, solvents, condensate,

acetic acid, settling tank overflow, and wash water are sampled at Stations 28, 29 and 31.

Compounding of the final product is accomplished in the "Incorporation" process where RDX or HMX are mixed with melted TNT (the resultant water layer being sewered) to form Composition B. This material is heated, wax is added, and then the mixture is solidified by passing it onto a cooled conveyor belt. In other operations in this series, the explosive in wet cake form is dried in kettles, perforated trays, or in drying ovens. In all cases the air used in drying is scrubbed with water before being discharged to the atmosphere. The wastewaters, containing explosives (including TNT), were sampled at Stations 28, 29 and 31.

In the TNT-receiving area, TNT is brought in by truck, unpackaged, and dumped into melt kettles for transportation to the "Incorporation" operation. Packaging of some compounded explosives is also carried out at these buildings. Explosive dusts are drawn to a wet scrubber for removal. The scrubber water and floor wash water flow to an industrial sewer through catch basins and were sampled at Stations 28 and 31.

The final step in explosives manufacturing occurs in the "Packaging" area. The explosives, received in barrels or carts, are packaged and loaded on trucks for shipment to local storage or to railroad loading docks. Dust is exhausted from the buildings and scrubbed with water. The scrubber water and floor and equipment washdown water were sampled at Stations 28, 29 and 31.

The 60-percent acetic acid solution from the "Washing" operation is sent to the "B-line" facilities for recovery of the acetic acid. The

solution contains acetic acid, nitric acid, and a small amount of RDX and HMX. First the solution is neutralized with sodium hydroxide and sent to a primary evaporator. About 80 percent of the feed is volatilized, condensed, and recovered as 60 percent acetic acid. The remaining 20 percent is withdrawn from the bottom of the evaporator as a sludge. The sludge is diluted and heated to about 100°C. During cooling, an RDX slurry is added as seed to aid crystallization of the RDX-HMX. The crystallized explosives are returned to the "Washing" operation.

The remaining liquid is sent to a secondary evaporator that recovers more acetic acid. The sludge from the secondary evaporators is steam stripped to recover the remaining acetic acid. (All recovered acetic acid is sent to Area A for purification and concentration.) Sodium hydroxide is added to the stripped sludge. This converts the ammonium nitrate in the sludge to sodium nitrate and ammonia, the residual acetic acid to sodium acetate, and the residual RDX and HMX to ammonia and sodium nitrate. The ammonia released in the reactor is absorbed in water and sent to an ammonia recovery area. The sludge from the reactor is pumped to storage lagoons for storage until a fertilizer facility is constructed. The waste flows, containing acetic acid and a small amount of ammonia, were sampled at Station 33.

Aqueous ammonia from the "B-line" is distilled to recover anhydrous ammonia, which is used as fertilizer, for impurities in the recovered anhydrous ammonia prevent its further use in manufacturing of explosives. The major impurities in the column bottoms are methyl amine and dimethyl amine; these are sampled at Station 33.

D. REFUSE ACT PERMIT APPLICATION (RAPP) DATA

In September 1971, the Holston Army Ammunition Plant submitted an application for a permit to discharge under the Refuse Act Permit Program [Table 7]. This table also shows the total pollutant loads from the Army Environmental Hygiene Agency survey of March to June 1971, the EPA survey station numbers consistent with the RAPP codes, and totals from the EPA survey.

The RAPP data and EPA survey results for BOD and SS agree closely. However, ammonia loads do not agree. A critical consideration is that the total content of ammonia in the waste stream will determine whether or not a special ammona-removal process is necessary. It is recommended that the ammonia content of the waste streams be closely surveyed before designing the final treatment processes.

E. DISCUSSION OF 1972 EPA FINDINGS

There were 12 sampling points at Area B [Figure 4 and Table 8]. Stations 25, 28, 29, 30, and 33 were manually sampled at two-hr intervals and composited on an equal-volume basis. Stations 26, 31, 32, 34, and 36 were sampled using a SERCO automatic sampler and composited on an equal-volume basis at the end of 24 hr. Grab samples were collected manually from stations 27 and 35 twice daily and combined to make one composite sample for each station. Temperature, pH, and conductivity were measured each time a manual sample was collected and at least three times per day at stations where automatic samplers were used. Samples for oil-and-grease analysis were 24-hr composites consisting of well-mixed grab samples collected every two hr (except for Station 31 which

TABLE 7

OUTFALL CHARACTERISTICS FROM RAPP APPLICATION, HOLSTON ARMY AMMUNITION PLANT-AREA B
KINGSPORT, TENNESSEE

RAPP Outfall Number	EPA Stn. No.[a]	Flow mgd	BOD		COD		SS		NH_3-N		TKN		NO_3-N		P-Total		Mn	
			mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
001	25	1.0	36	304	455	3,790	1,653	13,774	1	9	3	26	1	11	1	4	2	17
002	26	0.1	5	4	23	19	4	3					7	6	6	5		
003	27	- - - - - - - - - - - - - - - SURFACE DRAINAGE ONLY - NO INFORMATION GIVEN - - - - - - - - - - - - - - -

TABLE 8

DESCRIPTION OF EPA SAMPLING STATIONS, HAAP, AREA B
KINGSPORT, TENNESSEE
EPA SURVEY OF 12 THROUGH 15 DECEMBER 1972

Survey Station Number	Refuse Act Permit Discharge Number	Type of Sample	Station Location
25	001	Composite	Filter plant backwash, at manhole adjacent to perimeter road
26	002	Composite	Sewage treatment plant effluent, prior to chlorination
27	003	Grab	Surface water drainage from production lines 9 and 10, at open ditch adjacent to perimeter road
28	004	Composite	Process wastes at sewer outfall, adjacent to perimeter road
29[a/]	005	Composite	Process wastes and cooling water at outfall, adjacent to perimeter road
30[a/]	005	Composite	Cooling and surface waters from production lines 6 and 7, at sewer outfall adjacent to perimeter road
31[a/]	007	Composite	Process wastes from production lines 3, 4, and 5, at sewer outfall adjacent to perimeter road
32[a/]	007	Composite	Cooling water from production lines 3, 4, and 5, at sewer outfall adjacent to perimeter road
33	008	Composite	Main outfall ditch, at HAAP effluent water quality monitor station
34		Composite	Raw-water intake at Building 201 pumphouse
35		Grab	Arnotts Branch, upstream of nitric-acid production area
36		Composite	Raw-water intake at Building 209 pumphouse

a/ Flows at Stations 29 and 30 mixed together before entering the river. The same is true of flows at Stations 31 and 32.

was a composite of three equal volume grab samples taken over a 4 to 6 hr period).

Flow measurements were made at the following stations:

1. Measurements carried out at Stations 25 and 31 were made on instantaneous flows at two-hr intervals with a Marsh-McBirney electromagnetic water current meter. With the flow at Station 31 only being measured for 24 hr because the high river stage surcharged the outfall pipe;
2. Flows measured at Stations 26 and 27 were obtained using V-notch weirs and flow recorders;
3. The waste streams at Stations 28, 29, 30, 32, 33, and 35 were gaged several times daily during the study period, and a rating curve was established.

The flows at the remaining stations were extracted from HAAP records. The flows and analytical data obtained have been tabulated [Table 9].

The BOD of the raw water entering the plant was, from Arnotts Branch, 100 lb/day and, from the water in the Holston River, 4,130 lb/day. For suspended solids the load from Arnotts Branch was 4,400 lb/day and in the intake from the Holston River, 32,570 lb/day. The total BOD leaving the plant was 14,750 lb/day and the total suspended-solids content was 31,493 lb/day.

Therefore, the net contribution of the plant was about 10,000 lb BOD/day. The streams leaving the plant had about 5,000 lb of suspended solids/day less than the entering streams. This net loss of suspended solids cannot be explained on the basis of the information available.

TABLE 9

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT-AREA B
KINGSPORT, TENNESSEE

13-15 DECEMBER 1972

Station Number	25		26		27		28	
Station Description[a]	Filter Plant Backwash (RM 141.6)		Sewage Treatment Plant Effluent (RM 140.7)		Surface Water Drainage (RM 140.3)		Process Wastewaters (RM 139.7)	
Parameter[b]	Range	Average	Range	Average	Range	Average	Range	Average
Flow (mgd)	0.66-1.62	1.1	0.66-0.71	0.69	1.21-1.42	1.3	0.59-0.80	0.70
pH (standard units), range	6.5-7.9		7.5-8.5		6.6-7.1		3.2-7.9	
Temperature (°C), range	11.0-14.5		13.0-15.0		10.5-10.5		17.0-25.0	
Conductivity (µmhos/cm), range	300-850		420-500		220-280		260-800	
BOD	1.2-2.7	1.9	4.4-8.2	6.9	2.7-3.5	3.2	48->160	> 94
BOD (lb/day)		16		39		35		550
COD							41-407	224
TOC	5-6	5.6	7-8	7.3	5-9	6.6	12-115	47
Total Solids	313-441	369	314-335	324	161-176	167	249-350	269
Suspended Solids	7-36	21	2-15	8	12-42	22	11-80	34
Suspended Solids (lb/day)		160		43		240		220
Total Kjeldahl Nitrogen-N	N.D.[c]		0.9-1.1	1.0	0.6-1.0	0.77	8.8-35	17.6
Total Kjeldahl Nitrogen-N (lb/day)				5.70				106
NH_3-N	N.D.		< 0.5-0.6	< 0.5	N.D.		6.5-26	13.1
NH_3-N (lb/day)				< 2				78.8
NO_2 + NO_3-N	0.6-3.1	1.6	3.6-4.0	3.8	1.5-1.6	1.5	1.5-5.4	3.1
NO_2 + NO_3-N (lb/day)		13.3		21.5		16.6		180
Total Phosphorus-P	0.04-0.07	0.05	0.45-0.49	0.47	0.06-0.07	0.07	0.02-5.9	2.0
Total Phosphorus-P (lb/day)								13.2
Oil and Grease							1-23	10
Manganese	0.3-0.5	0.4						

TABLE 9 (Cont.)

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT-AREA B
KINGSPORT, TENNESSEE

13-15 DECEMBER 1972

Station Number	29		30		31		32	
Station Description[a]	Process Wastewaters (RM 139.6)		Cooling and Surface Waters (RM 139.6)		Process Wastewaters (RM 139.2)		Cooling and Surface Waters (RM 139.2)	
Parameter[b]	Range	Average	Range	Average	Range	Average	Range	Average
Flow (mgd)	3.02-3.97	3.54	11.5-14.4	13.2	2.1-2.5	2.3	8.22-9.11	8.8
pH (standard units), range	4.1-6.8		6.8-8.4		6.5-7.3		6.5-7.7	
Temperature (°C), range	20.0-22.5		15.0-19.0		15.0-18.0		12.5-15.5	
Conductivity (umhos/cm), range	260-380		200-340		230-340		210-260	
BOD	150-240	193	7.6-13	10.2	110-350	213	9.5-14.0	12
BOD (lb/day)		5680		1101		4090		840
COD	42-235	175			69-151	97		
TOC	24-56	44.2	4-8	6.3	24-38	28.7	8-10	8.7
Total Solids	197-231	217	156-199	180	180-228	203	218-246	232
Suspended Solids	10-20	15	32-41	36	6-11	8	67-96	79
Suspended Solids (lb/day)		440		3940		150		5800
Total Kjeldahl Nitrogen-N	1.0-7.1	3.95	0.6-0.7	0.6	0.9-1.6	1.2	0.6-0.8	0.73
Total Kjeldahl Nitrogen-N (lb/day)		120		70.1		24		53.5
NH_3-N	< 0.5-2.0	0.8	N.D.[c]		N.D.		N.D.	
NH_3-N (lb/day)		24.3						
NO_2 + NO_3 -N	3.9-8.8	5.9	1.2-3.6	2.0	2.1-2.7	2.4	0.9-1.0	1.0
NO_2 + NO_3 -N (lb/day)		170		212		47		70.4
Total Phosphorus-P	0.02-0.04	0.03	0.10-0.14	0.11	0.03-0.06	0.04	0.16-0.18	0.17
Total Phosphorus-P (lb/day)				12.7				12.4
Oil and Grease	4-10	7			5-23	11		
Manganese	0.1-0.2	0.15	0.3[d]	0.3				

TABLE 9 (Cont.)

SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL DATA
HOLSTON ARMY AMMUNITION PLANT-AREA B
KINGSPORT, TENNESSEE

13-15 DECEMBER 1972

Station Number	33		34		35		36	
Station Description[a]	Main Outfall Ditch (RM 137.9)		Intake Building 201 (RM 141.1)		Arnott Branch (RM 137.9/0.8)		Intake Building 209 (RM 139.0)	
Parameter[b]	Range	Average	Range	Average	Range	Average	Range	Average
Flow (mgd)	46.7-58.8	53.0		29[e]	9.87-12.9	11.4		55.4[e]
pH (standard units), range	6.5-7.8		6.8-7.8		7.2-7.4		7.2-7.9	
Temperature (°C), range	11.0-12.0		10.0-12.5		11.5-12.0		10.5-11.0	
Conductivity (umhos/cm), range	270-320		200-360		320-360		210-290	
BOD	3.5-7.4	5.5	1.4-2.8	2.2	0.4-2.0	1.1	6.9-8.7	7.8
BOD (lb/day)		2400				100		
TOC	5-6	5.7	4[d]	4	4-10	6	7[d]	7
Total Solids	215-287	255	162-199	178	229-402	295	205-229	218
Suspended Solids	22-65	47	22-25	24	32-54	43	52-62	58
Suspended Solids (lb/day)		20,500				4400		
Total Kjeldahl Nitrogen-N	< 0.5-0.5	< 0.5	< 0.5-0.6	0.5	N.D.[c]		< 0.5-0.5	< 0.5
Total Kjeldahl Nitrogen-N (lb/day)		<221						
NH_3- N	N.D.		N.D.		N.D.		N.D.	
NO_2 + NO_3-N	3.2-5.8	4.3	0.9-1.7	1.2	1.2-1.6	1.4	1.1-1.9	1.5
NO_2 + NO_3-N		1920				137		
Total Phosphorus-P	0.09-0.10	0.10	0.09-0.10	0.10	0.03-0.20	0.09	0.08-0.12	0.10
Total Phosphorus-P (lb/day)		42.7				8.24		
Oil and Grease	< 1-2	< 1.0			< 1-5	2		
Manganese	0.08-0.1	0.09	0.2-0.3	0.2			0.1[d]	0.1

a/ See Table 7 for Station Description.
b/ All values reported as mg/l, except where otherwise specified.
c/ N.D. - None Detected.
d/ All values are the same.
e/ This value was obtained from HAAP records.

It seems likely that the BOD reading (14,750 lb/day) is not representative of total organic content because of the presence of complex organic materials that may not exert an oxygen demand. The TOC leaving the plant totaled only about 6,100 lb/day. (Very few, if any, organic materials are resistant to the TOC analysis.) The presence of suspended solids may have made the TOC readings low in that, possibly, a representative sample was not introduced into the TOC analyzer.

Only about 100 lb/day of ammonia were in the effluent streams, but almost 2,500 lb/day of oxidized nitrogen (NO_2 and NO_3) are released to the river, and this should be reduced before being discharged.

Complex organic analyses were performed on samples collected from Stations 28 and 29 with a combined flow of 4.24 mgd. These waste discharges result from the explosives manufacturing phase of the HAAP Area B process [Table 8]. Samples were also collected from Stations 31 and 33 and analyzed for complex organics. These waste discharges had a combined flow of 55.3 mgd and resulted from process effluents from production lines 3, 4 and 5, as well as the Main Outfall [Table 8]. The analyses were conducted on an equal aliquot from the listed outfalls.

Compounds isolated are listed in Table 10. The quantities of trinitrotoluene (TNT) and cyclohexanone discharged by the Holston Army Ammunition Plant, Area B, represent a serious hazard to aquatic life in the receiving waters of the Holston River. The amount of cyclohexanone discharged from Stations 28 and 29 ranged between 15.3 lb/day and 76.9 lb/day. The quantity of TNT in this discharge was between 9.1 lb/day and 46 lb/day. The amount of cyclohexanone discharged in the effluents

TABLE 10

ORGANIC POLLUTANTS IDENTIFIED
HOLSTON ARMY AMMUNITION PLANT-AREA B
DECEMBER 1972

Sample Stations	Compound	Concentration (mg/l)
28 and 29	cyclohexanone	1.30
	2,4,6-trinitrotoluene	0.78
	2-cyclohexylcyclohexanone	0.02*
31 and 33	cyclohexanone	1.40
	2-nonanone	0.02*
	di-n-butylketone	0.005*
	2,2-dimethyloctanol	0.005*
	1,11-dodecadiene	0.005*
	2 or 4-sec-butylcyclohexanol	0.030*
	phthalic acid esters (unidentified)	0.50*
	3,6-dimethyl-6-isopropyl-2-cyclohexanone	0.015*
	2-cyclohexylcyclohexanone	0.010*

* Estimated - Standard not available for confirmation.

from Stations 31 and 33 ranged between 54 lb/day and 1,240 lb/day. These quantities are likely to result in adverse effects of a chronic nature through continuous exposure of aquatic life.

Static bioassay studies on streams 29 and 30 after mixing, but prior to entering the river, had a 96-hr TL_m value of 23 percent. The combined flow was 16.72 mgd. A factor 1/20 was employed to obtain a river flow that would dilute this so that there would be no long-term impact on aquatic life. A bioassay on stream 31 (at 2.3 mgd) also indicated a 96-hour TL_m of 23 percent. Similar calculations were performed on this flow. The summation of the two bioassay calculations disclosed that a minimum flow of 2,600 cfs would have to be maintained in the river to ensure no long-term impact on aquatic life from toxic effects. This figure does not include dilution water that would be necessary to protect the aquatic life from wastewater discharges at Area A or from other sources in the area.

F. FUTURE WASTE ABATEMENT SCHEDULE

The Federal Water Pollution Control Act Amendments of 1972 and Executive Order 11507 apply to Area B as well as to Area A. [See discussion of the Act in the report on Area A.]

MUCOM has proposed schedules for identified pollution abatement projects at HAAP, Area B [Table 11]. No funds have been appropriated beyond Fiscal Year 1973. During the EPA survey, no construction had been started for Area B pollution control facilities.

Relative to the overall MUCOM pollution-abatement schedule -- based

TABLE 11

PROPOSED POLLUTION-ABATEMENT SCHEDULE
HAAP, AREA B - KINGSPORT, TENNESSEE[47]

Item	Funding FY	Estimated Completion FY	Remarks
		W A T E R	
Boiler blowdown Bldgs. 200, 222 treatment to aerated lagoon	72	74	Design criteria complete. Architect-Engineer evaluating design criteria.
Filter-plant sludge	72	74	Design complete. Design and performance criteria not known by EPA. Includes 7-acre drying bed.
Process-area dike system	72	74	Contract let and contractor working 10/72. Includes 2 spill containment ponds. Effluent from these ponds to be returned to Area B treatment system.
Pumphouse trash removal	72		Solids removed and sent to incinerator.
Industrial waste treatment - aerated lagoon	72	76	Design completed. Contract being negotiated with Clark-Dietz. Design criteria as specified by CERL not satisfactory. AFSA guidelines should be used as design criteria.
Total segregation of uncontaminated cooling water from process water			Specified in 1971 MUCOM Report but no real follow up in pollution abatement schedules.
Remove sodium nitrate from holding ponds and replace sodium nitrate process units			Plans unknown
Water and Air Pollution Monitoring System	73	75	
Ammonia-rich waste streams should be subjected to ammonia stripping			Plans unknown

TABLE 11 (Cont.)

PROPOSED POLLUTION-ABATEMENT SCHEDULE
HAAP, AREA B - KINGSPORT, TENNESSEE[a/]

Item	Funding FY	Estimated Completion FY	Remarks
		A I R	
Electrostatic precipitators on pulverized coal boilers	72	73	No details
Ammonia oxidation Dupont AOP units	72	75	Pilot test using molecular sieve on AOP unit to remove NO_x from air.
Magnesium concentration units (MAGGIE units)			Deferred to October 1975. No details on design.
NO_x Control and Treatment			Both NO_x and SO_x abatement technology being studied by MUCOM on an overall facilities basis. Prototype units now in development stage including molecular sieve for NO_x which is fairly advanced. NO_x and SO_x problems considered reasonably critical
SO_x Control and Treatment			
		S O L I D S[b/]	
Refuse disposal incinerator - nonexplosive	72	74	Completion date October 1973. Twenty ton/day
Explosives incinerators	73	76	Two incinerators: a 2 ton/day and an 11 ton/day These three incinerators should eliminate all open-pit burning.

a/ Other items have been cited in MUCOM, USAEHA and HAAP reports, but these items are either ambiguous or do not have a demonstrated impact on water-abatement progress.

b/ Open burning procedures for trash, debris, packaging materials spent process, and explosives materials, etc. continue to represent current practices. Even though this report has not emphasized the problems of open burning and solid-waste disposal, air pollution from open burning has been severe in many instances. Advanced technology is urgently needed.

upon a preliminary analysis of the schedule, a number of potential deficiencies are apparent [mentioned in the "remarks" column in Table 11].

Water Pollution

On the basis of a survey by the Army Environmental Hygiene Agency, the Army Construction Engineering Research Laboratory (CERL) provided recommendations and design criteria for pollution-control facilities at Area B. These recommendations included:

1. The water treatment plant settlers should be revised to permit continuous sludge removal, with the sludge being thickened and spread on sand beds for dewatering to approximately 20-percent solids and then disposed of in a sanitary landfill.
2. All non-contaminated cooling-water streams should be separated from process waste streams and discharged directly to the river.
3. Ammonia-rich waste streams should be treated at the source by ammonia stripping to reduce the ammonia content prior to introduction to the industrial waste treatment system.
4. The combined industrial wastes, with phosphate added as a nutrient, should be treated in aerated lagoons with a minimum of 15 hr aeration, and the mixed liquor should be settled and the settler effluent discharged to the river with waste sludges being stabilized by aerobic digestion and ultimately disposed of by land spreading.

Standards established by the State of Tennessee were used by CERL as the basis for the design of the waste-treatment facilities. These standards require maximum effluent limitations of 450 mg/l BOD and

180 mg/l suspended solids. The Army Ammunition Procurement and Supply Agency has proposed standards (APSAR 11-11) requiring a maximum BOD of 15 mg/l and a suspended solids content not to exceed 25 mg/l. The maximum ammonia content was set at 0.1 mg/l and nitrate at 5 mg/l. The maximum TNT and nitrobodies content was set at 0.5 mg/l. The total heavy-metals content was set at 5.0 mg/l (max).

CERL has conducted treatability studies on selected effluents from the Holston Army Ammunition Plant explosives-manufacturing area. Using acclimated organisms, the Laboratory found that the wastes were not toxic to organisms and were, therefore, treatable by a biological process. Because of the complex and toxic organic materials present it is questionable whether a biomass can be kept viable under these conditions. If the biomass does survive, it is most unlikely that it will degrade complex organic materials such as RDX, HMX, TNT, and cyclohexanone.

It is recommended that HAAP proceed immediately with separation of non-contaminated cooling water from the process-waste streams. If the resultant process-waste stream is compatible with biological treatment, this should be the first stage in the treatment system. If biological treatment is not applicable, the first stage could consist of chemical coagulation followed by flocculation and sedimentation. Either process should be designed to give a product with a suspended-solids content of 30 mg/l or less.

Regardless of whether the first stage treatment is biological or chemical in nature, a second stage, possibly consisting of adsorption on activated carbon or oxidation with ozone, will be necessary. Because

of the explosive nature of some of the contaminants, thermal regeneration of the carbon may not be feasible, and ozonation would be the process of choice. This second-stage treatment is necessary, even after biological oxidation, to remove the complex organic materials that, in many cases, are extremely toxic substances.

If the concentrated waste stream is not amenable to biological oxidation, and if the first two stages consist of chemical treatment and carbon adsorption, it is likely that acetic acid and any other low molecular weight organic materials will not be adsorbed on the carbon or, at best, will be adsorbed to only a slight degree. If the ratio of low-molecular-weight organic materials to the nitrate ion is not too high, these materials will be removed in the denitrification process (discussed in the next paragraph). If the low-molecular-weight organic materials are in excess of that needed for dentrification, an aerobic biological-treatment process should be carried out after carbon adsorption.

Because of the high concentration of nitrate ions in the wastewater, even after the first and second stages, a nitrogen-removal step will be necessary to reduce the high algae growth potential of the receiving stream. Because all of the nitrogen will be in the oxidized state, a biological denitrification process is the logical step for this stage. It is conventional to use methanol as a substrate for this process but, in this case, it could be less expensive and more convenient to use acetic acid as the substrate. It could also be necessary to add phosphate ion to the denitrification reactor.

The final effluent from this series of operations will be low in

oxygen demand, suspended solids, and nitrogen forms and will not pose a pollution threat to the Holston River.

Air Pollution

There are four main sources of air pollution in Area B. These are:

1. Nitric-acid producers;
2. Nitric-acid concentration;
3. Open burning of trash; and
4. Steam production.

The nitric-acid producers, at full capacity, release about 17,000 lb of NO_x/day to the atmosphere. The level of NO_x in the general area is greater than 5 ppm, the maximum level recommended for personnel.

The nitric-acid concentrators, at full production, contribute about 5,200 lb of NO_x/day.

About 13 tons of refuse and explosive wastes are burned each day by open burning techniques. It is estimated that this operation adds 1,410 lb of contaminants to the atmosphere each day.

The six coal-fired and the three natural-gas or oil-fired boilers release about 28,000 lb of particulates and 11,000 lb of sulfur oxides to the atmosphere each day.

Refuse disposal is to be handled by sanitary landfill or by incineration with wet scrubbing of the stack gas. Design criteria are available for an explosives incinerator.

Consideration is being given to the use of electrostatic precipitators or wet scrubbers to remove particulate matter from the boiler-building stack gas.

The control of SO_x and NO_x from the incinerators and steam generators has not been given much consideration. Use of low-sulfur coal may solve the SO_x problem, and NO_x can be reduced by control of combustion temperatures, by catalytic reducers, or by molecular sieves.

Little consideration has been given to the volatile organic wastes released to the atmosphere from the various manufacturing operations in Area B. These materials include cyclohexanone, toluene, acetone, acetic acid, and methyl nitrate, a by-product of the nitration operation. Studies should be undertaken to determine the extent of pollution from these sources and, as required, control measures should be developed and installed.

In all pollution-control operations, care should be taken to assure that the pollution is not transferred from water to the atmosphere or vice versa.

ACKNOWLEDGEMENT AND REFERENCES

Several documents by personnel from the Department of the Army were used extensively in the preparation of this report. These documents provided information, as well as some tables and figures used in the report.

The Documents used were:

1. *Comprehensive Technical Evaluation Study-Holston Army Ammunition Plant, Kingsport, Tennessee.* Department of Defense, Department of the Army, Construction Engineering Research Laboratory. Champaign, Illinois. July 1972.

2. *Military Explosives* Department of the Army Technical Manual TM9-1300-214 and Department of the Air Force Technical Order TO 11A-1-34. Department of Defense. November 1967.

3. W. Heidelberger. *Holston Army Ammunition Plant Pollution and Abatement Plans* Technical Report 4286. Process Automation and Pollution Abatement Division, Manufacturing Technology Directorate, Picatinny Arsenal, Department of Defense. Dover, New Jersey. November 1971.

4. *Water Quality Engineering Special Study No. 24-021-71/72, Industrial Wastewater-Holston Army Ammunition Plant-Kingsport, Tennessee. 19 March-28 June, 1971.* Department of the Army, U. S. Army Environmental Hygiene Agency, Edgewood Arsenal, Department of Defense. Aberdeen Proving Ground, Maryland.

APPENDIX A

GENERAL WATER QUALITY CRITERIA
FOR THE DEFINITION AND CONTROL OF POLLUTION
IN THE WATERS OF TENNESSEE

GENERAL WATER QUALITY CRITERIA FOR THE DEFINITION AND CONTROL OF POLLUTION IN THE WATERS OF TENNESSEE

Adopted on May 26, 1967
Amended on November 17, 1967, May 22, 1970, October 26, 1971, and December 14, 1971

Tennessee Water Quality Control Board*

The Water Quality Control Act of 1971, Chapter 164 Public Acts of 1971 as Amended by Chapter 386, makes it the duty of the Water Quality Control Board to study and investigate all problems concerned with the pollution of the waters of the State and with its prevention, abatement, and control and to establish such standards of quality for any waters of the State in relation to their reasonable and necessary use as the Board shall deem to be in the public interest and establish general policies relating to existing or proposed future pollution as the Board shall deem necessary to accomplish the purpose of the Control Act. The following general considerations and criteria are officially adopted by the Board as a guide in determining the permissible conditions of waters with respect to pollution and the preventive or corrective measures required to control pollution in various waters or in different sections of the same waters.

GENERAL CONSIDERATIONS

1. Waters have many uses which in the public interest are reasonable and necessary. Such uses include: sources of water supply for domestic and industrial purposes; propagation and maintenance of fish and othe desirable aquatic life; recreational boating and fishing; the final disposal of municipal sewage and industrial waste following adequate treatment; stock watering and irrigation; navigation; generation of power; and the enjoyment of scenic and esthetic qualities of the wate.

2. The rigid application of uniform water quality is not desirable or reasonable because of the varying uses of such waters. The assimilat capacity of a stream for sewage and waste varies depending upon vario factors including the following: volume of flow, depth of channel, t presence of falls or rapids, rate of flow, temperature, natural characteristics, and the nature of the stream. Also the relative importance assigned to each use will differ for different waters and sections of waters throughout the stream.

3. To permit reasonable and necessary uses of the waters of the State, existing pollution should be corrected as rapidly as practical and future pollution controlled by treatment plants or other measures. There is an economical balance between the cost of sewage and waste treatment and the benefits received. Within permissible limits, the dilution factor and the assimilative capacity of surface water should be utilized. Waste recovery, control of rates and dispersion of waste into the streams, and control of rates and characteristics of flow of waters in the stream where adequate, will be considered to be a means of correction.

* Fully Approved on June 2, 1972, by the Environmental Protection Agency.

4. Sewage, industrial wastes, or other wastes, as defined in The Water Quality Control Act of 1971, Chapter 164 Public Acts of 1971, as amended by Chapter 386, shall not be discharged into or adjacent to streams or other surface waters in such quantity and of such character or under such conditions of discharge in relation to the receiving waters as will result in visual or olfactory nuisances, undue interference to other reasonable and necessary uses of the water, or appreciable damage to the natural processes of self-purification. In relation to the various qualities and the specific uses of the receiving waters, no sewage, industrial wastes, or other wastes discharged shall be responsible for conditions that fail to meet the criteria of water quality outlined below. Bypassing or accidental spills will not be tolerated.

The criteria of water quality outlined below are considered as guides in applying the water quality objectives in order to insure reasonable and necessary uses of the waters of the State. In order to protect the public health and maintain the water suitable for other reasonable and necessary uses; to provide for future development; to allow proper sharing of available water resources; and to meet the needs of particular situations, additional criteria will be set.

CRITERIA OF WATER CONDITIONS

1. Domestic Raw Water Supply

   (a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

   (b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a perio of 24 hours.

   (c) Hardness or Mineral Compounds - There shall be no substances adde to the waters that will increase the hardness or mineral content of the waters to such an extent to appreciably impair the usefulness of the water as a source of domestic water supply.

   (d) Total Dissolved Solids - The total dissolved solids shall at no time exceed 500 mg/l.

   (e) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formatic of slimes, bottom deposits or sludge banks of such size or charac as may impair the usefulness of the water as a source of domestic water supply.

   (f) Turbidity or Color - There shall be no turbidity or color added i amounts or characteristics that can not be reduced to acceptable concentrations by conventional water treatment processes.

(g) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(h) Microbiological Coliform - Coliform group shall not exceed 10,000 per 100 ml. as a monthly average value (either MPN or MF count); nor exceed this number in more than 20 per cent of the samples examined during any month; nor exceed 20,000 per 100 ml. in more than five per cent of such samples. These values may be exceeded provided the organisms are known to be of nonfecal origin. No disease producing bacteria or other objectionable organisms shall be added to surface waters which will result in the contamination of said waters to such an extent as to render the water unsuitable as sources of domestic water supply after conventional water treatment.

(i) Taste or Odor - There shall be no substances added which will result in taste or odor that prevent the production of potable water by conventional water treatment processes.

(j) Toxic Substances - There shall be no toxic substances added to the waters that will produce toxic conditions that materially affect man or animals or impair the safety of a conventionally treated water supply.

(k) Other Pollutants - Other pollutants shall not be added to the water in quantities that may be detrimental to public health or impair the usefulness of the water as a source of domestic water supply.

2. Industrial Water Supply.

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to the waters that will increase the hardness or mineral content of the waters to such an extent as to appreciably impair the usefulness of the water as a source of industrial water supply.

(d) Total Dissolved Solids - The total dissolved solids shall at no time exceed 500 mg/l.

(e) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as may impair the usefulness of the water as a source of industrial water supply.

(f) Turbidity or Color - There shall be no turbidity or color added in amounts or characteristics that can not be reduced to acceptable concentrations by conventional water treatment processes.

(g) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(h) Taste or Odor - There shall be no substances added that will result in taste or odor that would prevent the use of the water for industrial processing.

(i) Toxic Substances - There shall be no substances added to the waters that may produce toxic conditions that will adversely affect the water for industrial processing.

(j) Other Pollutants - Other pollutants shall not be added to the waters in quantities that may adversely affect the water for industrial processing.

3. Fish and Aquatic Life.

(a) Dissolved Oxygen - The dissolved oxygen shall be maintained at 5.0 mg/l except in limited sections of the stream receiving treated effluents. In these limited sections, a minimum of 3.0 mg/l dissolved oxygen shall be allowed. The dissolved oxygen content shall be measured at mid-depth in waters having a total depth of ten (10) feet or less and at a depth of five (5) feet in waters having a total depth of greater than ten (10) feet. A minimum dissolved oxygen content of 6.0 mg/l shall be maintained in recognized trout streams.

(b) pH - The pH value shall lie within the range of 6.5 to 8.5 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life.

(d) Turbidity or Color - There shall be no turbidity or color added in such amounts or of such character that will materially affect fish and aquatic life.

(e) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of recognized trout waters shall not exceed 20°C. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(f) Taste or Odor - There shall be no substances added that will impart unpalatable flavor to fish or result in noticeable offensive odors in the vicinity of the water or otherwise interfere with fish or aquatic life.

(g) Toxic Substances - There shall be no substances added to the waters that will produce toxic conditions that affect fish or aquatic life.

(h) Other Pollutants - Other pollutants shall not be added to the waters that will be detrimental to fish or aquatic life.

4. Recreation.

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to recreation.

(d) Turbidity or Color - There shall be no turbidity or color added in such amounts or character that will result in an objectionable appearance to the water.

(e) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(f) Microbiological Coliform - The fecal coliform group shall not exceed 5,000 per 100 ml. as a monthly average value nor exceed this number in more than 20 per cent of the samples examined during any month nor exceed 20,000 per 100 ml. in more than five per cent of such samples. In those waters that are physically suitable and available to the public for water-contact recreation the fecal

coliform concentration shall not exceed 1,000 per 100 ml. in any two consecutive samples collected during the months of May through September. Water areas near outfalls of domestic sewage treatment plants are not considered suitable for water-contact recreation.

(g) Taste or Odor - There shall be no substances added that will result in objectionable taste or odor.

(h) Toxic Substances - There shall be no substances added to the water that will produce toxic conditions that affect man or animal.

(i) Other Pollutants - Other pollutants shall not be added to the water in quantities which may have a detrimental effect on recreation.

5. Irrigation

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to the water that will increase the mineral content to such an extent as to impair its use for irrigation.

(d) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as may impair the usefulness of the water for irrigation purposes.

(e) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for irrigation purposes.

(f) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for irrigation.

(g) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the waters used for irrigation.

6. Livestock Watering and Wildlife

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to water that will increase the mineral content to such an extent as to impair its use for livestock watering and wildlife.

(d) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as to interfere with livestock watering and wildlife.

(e) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for livestock watering and wildlife.

(f) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for livestock watering and wildlife.

(g) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the water for livestock watering and wildlife.

7. Navigation

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) Hardness or Mineral Compounds - There shall be no substances added to the water that will increase the mineral content to such an extent as to impair its use for navigation.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as to interfere with navigation.

(d) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for navigation purposes.

(e) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for navigation.

(f) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the waters used for navigation.

These criteria should not be construed as permitting the degradation of higher quality water when such can be prevented by reasonable pollution control measures. The above conditions are recognized as applying to waters affected by the discharge of sewage and/or industrial waste or other waste and not resulting from natural causes.

DEFINITIONS

1. Conventional Water Treatment - Conventional water treatment as referred to in the criteria denotes coagulation, sedimentation, filtration and chlorination.

2. Mixing Zone - Mixing zone refers to that section of flowing stream or impounded waters necessary for effluents to become dispersed.

   The mixing zone necessary in each particular case shall be defined by the Tennessee Water Quality Control Board.

INTERPRETATION OF CRITERIA

1. Interpretations of the above criteria shall conform to any rules and regulations or policies adopted by the Water Quality Control Board.

2. Insofar as practicable, the effect of treated sewage or waste discharges on the receiving waters shall be considered after they are mixed with the waters and beyond a reasonable zone of immediate effect upon the qualities of the waters. The extent to which this is practicable depends upon local conditions and the proximity and nature of other uses of the waters.

3. The technical and economical feasibility of waste treatment, recovery, or adjustment of the method of discharge to provide correction shall be considered in determining the time to be allowed for the development of practicable methods and for the specified correction.

4. The criteria set forth shall be applied on the basis of the following stream flows: unregulated streams - stream flows equal to or exceeding the 3-day minimum, 20-year recurrence interval; regulated streams - instantaneous minimum flow.

5. In general, deviations from normal water conditions may be undesirable, but the rate and extent of the deviations should be considered in interpreting the above criteria.

6. The criteria and standards provide that all discharges of sewage, industrial waste, and other wastes will receive the best practicable treatment (secondary or the equivalent) or control according to the policy and procedure of the Tennessee Water Quality Control Board. A degree of treatment greater than secondary when necessary to protect the water uses will be required for selected sewage and waste discharges.

TENNESSEE ANTIDEGRADATION STATEMENT A-9

1. The Standards and Plan adopted are designed to provide for the protection of existing water quality and/or the upgrading or "enhancement" of water quality in all waters within Tennessee. It is recognized that some waters may have existing quality better than established standards.

2. The Criteria and Standards shall not be construed as permitting the degradation of these higher quality waters when such can be prevented by reasonable pollution control measures. In this regard, existing high quality water will be maintained unless and until it is affirmatively demonstrated to the Tennessee Water Quality Control Board that a change is justifiable as a result of necessary social and economic development.

3. All discharges of sewage, industrial waste, or other waste shall receive the best practicable treatment (secondary or the equivalent) or control according to the policy and procedure of the Tennessee Water Quality Control Board. A degree of treatment greater than secondary when necessary to protect the water uses will be required for selected sewage and waste discharges.

4. In implementing the provisions of the above as they relate to interstate streams, the Tennessee Water Quality Control Board will cooperate with the appropriate Federal Agency in order to assist in carrying out responsibilities under the Federal Water Pollution Control Act, as amended.

December 17, 1971

APPENDIX B

SAMPLING PROCEDURE

SAMPLING PROCEDURE

Fifty-six sampling locations were established for the waste source and stream survey. These locations included direct discharges from seven industries to the Holston River and its tributaries, in-plant waste streams at Holston Mills, ASG Industries and Tennessee Eastman Company, and four stations in the Holston River.

The majority of the industrial waste samples were collected hourly by using automatic samplers and composited on an equal volume basis at the end of each 24-hour period. Where automatic samplers could not be used, samples were collected manually every two hours and composited on an equal volume basis.

Temperature, pH and conductivity were determined periodically. Samples were analyzed for solids, COD, TOC, nutrients, sulfates, organics, fluorides, metals and alkalinity. Grab samples for phenolic and oil and grease analyses were composited over a 4-6 hour period.

Samples for BOD, solids, phenolics, sulfide, color, alkalinity and oil and grease extractions were analyzed in the EPA mobile laboratory. COD, TOC, nutrients, sulfates, and fluoride analyses were performed at the NFIC laboratory in Cincinnati, Ohio. Organic samples were analyzed at the NFIC laboratories in Denver and Cincinnati.

Sediment samples were collected at stream stations 10-53, 54, and -56, using a Pheleger core sampler. These samples were immediately

packed with dry ice and shipped to the NFIC laboratory in Cincinnati for analyses.

Flow measurements were obtained from company records and flow meters, if available. Where necessary, EPA personnel installed flow measuring devices and recording equipment, or, if this was not possible, instantaneous flow measurements were taken using a Marsh-McBirney flow meter.

APPENDIX C

METHODS OF ANALYSIS AND SAMPLE PRESERVATION

METHODS OF ANALYSIS AND SAMPLE PRESERVATION

Analyses for COD, sulfate, sulfide, phenolics, and BOD and DO were conducted according to standard methods (using the azide modification of the Winkler technique).*

All other laboratory analyses and field measurements were carried out in accordance with accepted standard techniques.**

Samples collected in the field were preserved as follows:

Sample for Analysis of-	Preservative
Sulfate Fluoride	None
BOD Solids Sulfide Organics Alkalinity	Ice***
Sediment	Dry ice***
Nutrients COD TOC	1 ml conc. H_2SO_4/1
Metals	2 ml conc HNO_3/1
Oil & Grease	2 ml conc H_2SO_4/1
Phenolics	1 gm $CuSO_4$ + 1 ml conc H_3PO_4/1

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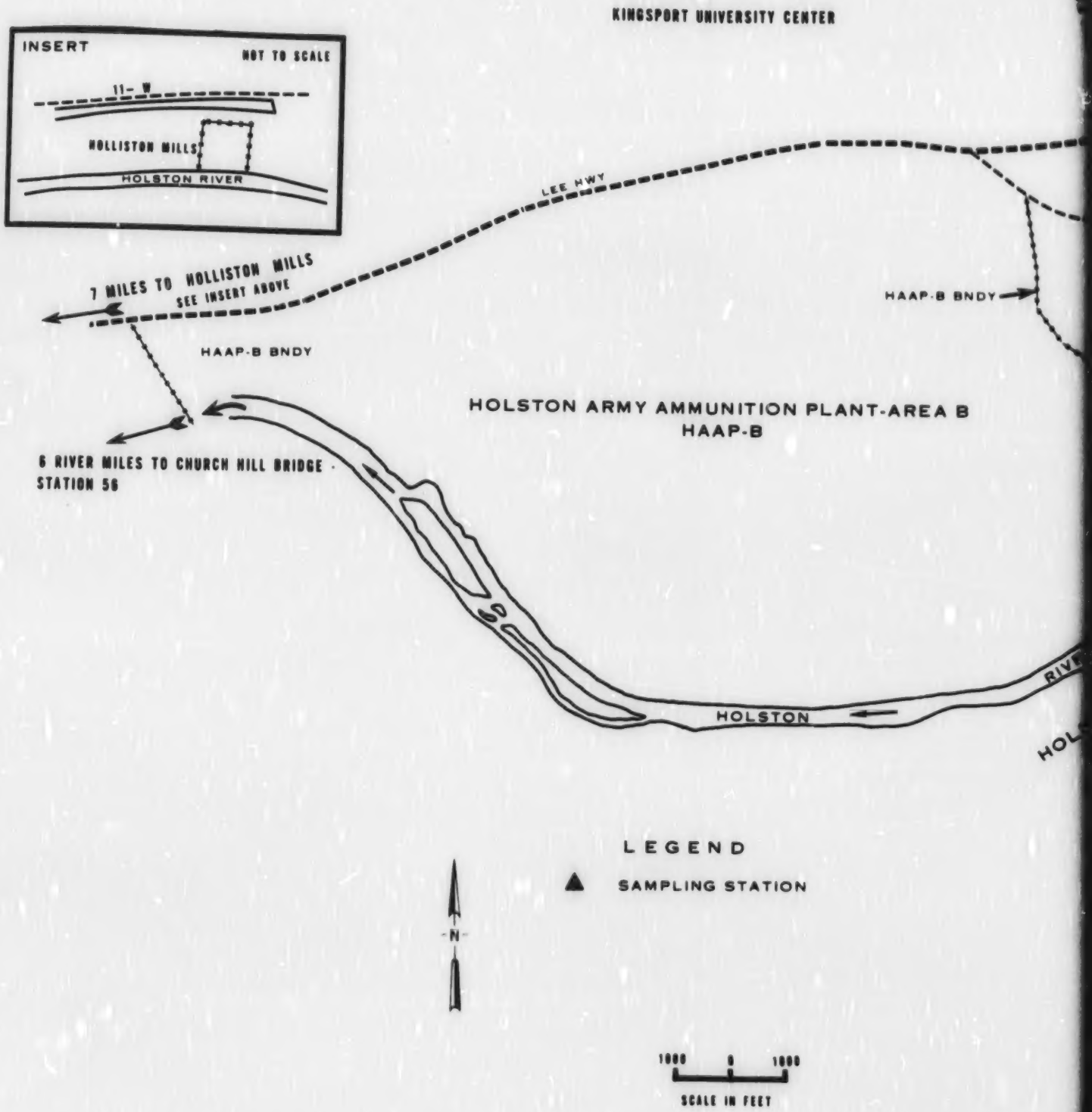
* M. J. Tarus, A. E. Greenberg, R. D. Hoak, and M. C. Rand, *Standard Methods for the Examination of Water and Wastewater*, 13th Edition, American Public Health Association. New York, New York. 1971.

** *Methods for Chemical Analysis of Water and Wastes*, Environmental Protection Agency, National Environmental Research Center, Analytical Quality Control Laboratory. Cincinnati, Ohio. July 1971.

*** Ice was packed around sample containers to lower temperature and retard bacteriological degradation.


KINGSPORT UNIVERSITY CENTER
INSERT
NOT TO SCALE
11- W
HOLLISTON MILLS
HOLSTON RIVER
LEE HWY
7 MILES TO HOLLISTON MILLS
SEE INSERT ABOVE
HAAP-B BNDY
HAAP-B BNDY
HOLSTON ARMY AMMUNITION PLANT-AREA B
HAAP-B
6 RIVER MILES TO CHURCH HILL BRIDGE
STATION 56
HOLSTON
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SAMPLING STATION
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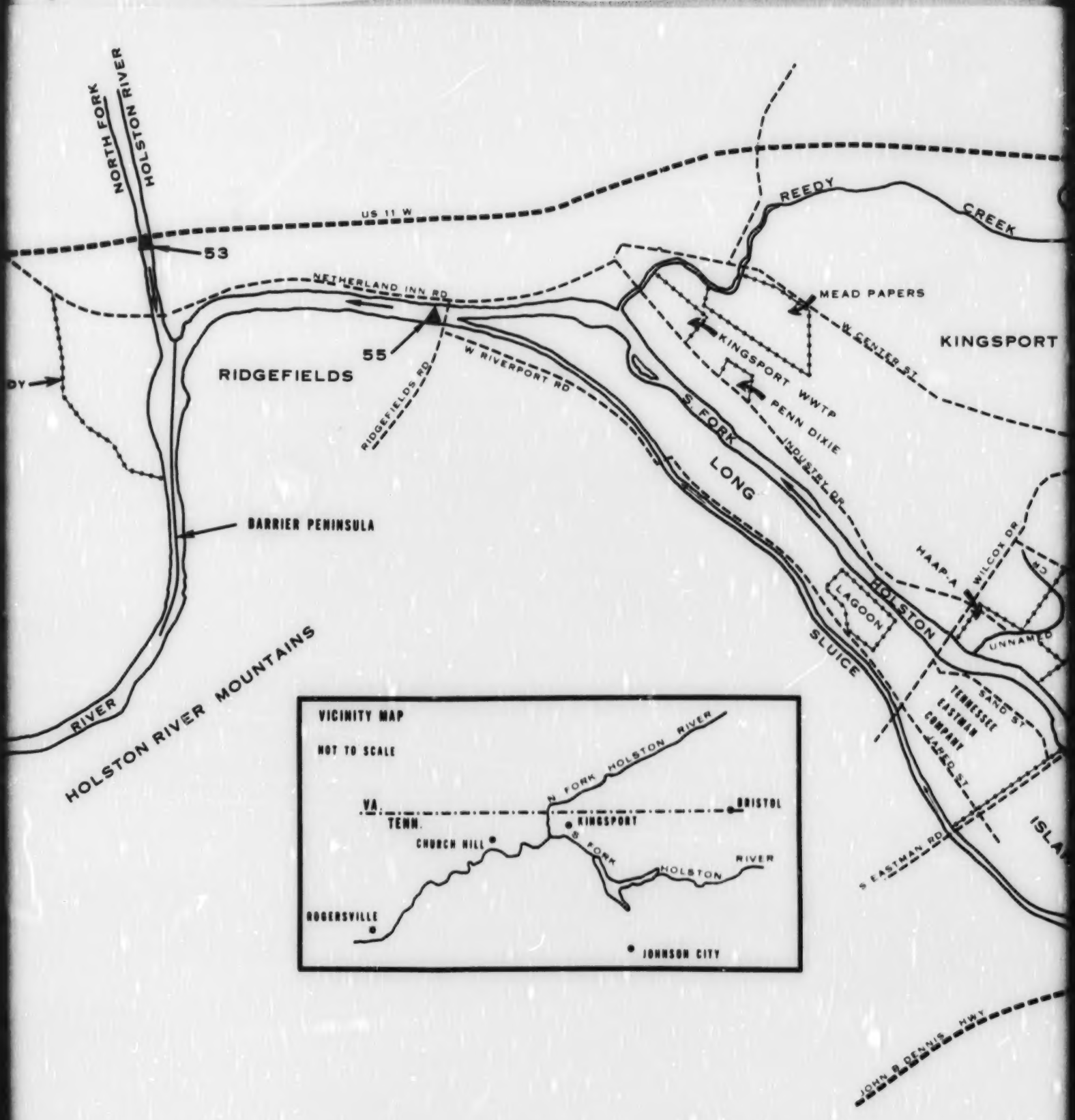

Figure IV-1. Study Area

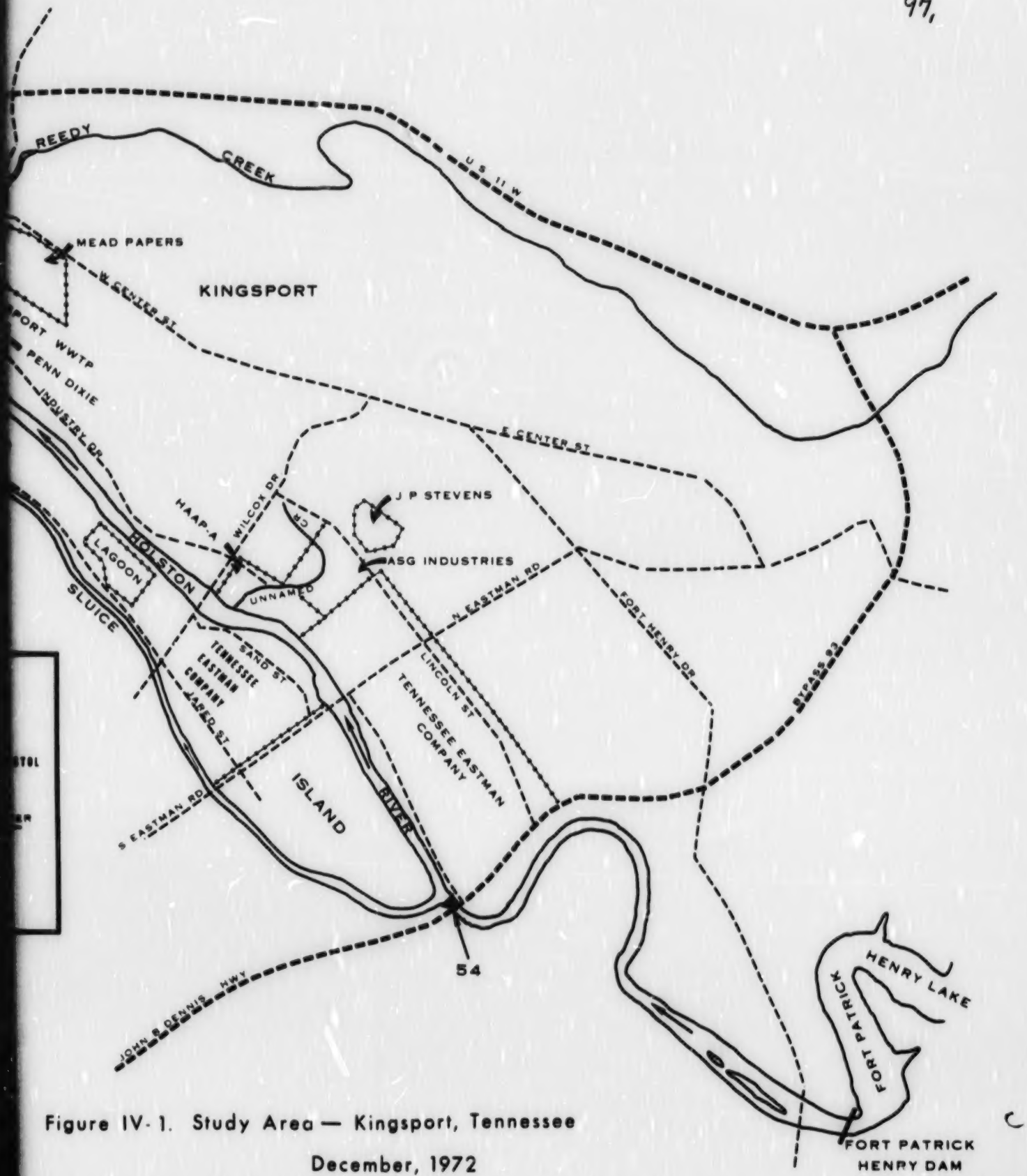

Figure IV-1. Study Area — Kingsport, Tennessee

December, 1972